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PREPARING THE NATION FOR NATURAL DISASTERS

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

PREPARING TENNESSEE AND THE NATION FOR NATURAL DISASTERS

DECEMBER 11, 1989

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PREPARING THE NATION FOR NATURAL DISASTERS

MONDAY, DECEMBER 11, 1989

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Memphis, TN.

The subcommittee met, pursuant to notice, at 9:23 a.m. in room 136, Fogelman Executive Center, Memphis State University, Memphis, Tennessee, Hon. Albert Gore (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Mike Nelson, professional staff member and Fiona Branton, minority staff counsel.

OPENING STATEMENT BY SENATOR GORE

Senator GORE. Ladies and gentlemen, the hearing will come to order. I would like to welcome all of our guests and all of the witnesses who will be testifying here today. I am particularly honored and pleased to welcome Senator Wendell Ford of the Senate Commerce Committee, who is going to be joining me in conducting this hearing. Our neighbors to the north in Kentucky along with us have long been concerned about how we can better prepare for the consequences of an earthquake along the New Madrid fault line.

I might also say that Senator Jack Danforth is on our Committee and frequently speaks about the concerns of citizens in Missouri. Our three states, Tennessee, Kentucky and Missouri, all have a common interest in improving the level of preparedness for an eastern earthquake.

The Science subcommittee of the Commerce Committee oversees federal efforts to help our cities and states prepare for catastrophic earthquakes. The purpose of this hearing today is to learn what we can do to improve earthquake preparedness in our part of the country. I am glad that this hearing could be held in Memphis and that it could be scheduled to coincide with the annual meeting of CUSEC, the Central United States Earthquake Consortium. CUSEC has done a great job in improving earthquake preparedness in this part of the country. Today's meeting ought to help further our efforts by alerting people to the earthquake threat. I want to thank Harvey Ryland, the Executive Director of CUSEC; Lacy Suiter, the Director of Tennessee's Emergency Management Agency and Dr. Arch Johnston, Director of the Center for Earthquake Research and Information here at Memphis State for all that they have done to make this hearing possible.

The recent earthquake in northern California which jolted millions of people in the Bay area has had an impact far beyond California. The minute-by-minute story of destruction which unfolded on our television screens reminded Americans everywhere that we cannot be complacent about the threat of earthquakes.

In California in only an instant 62 people were killed and 2,400 people were injured. In all about $8 billion in damage was done, making the quake one of the most costly natural disasters in U.S. history. Yet it was not the Big One that everyone fears. When the so-called big one hits California, thousands of people will die and the damage is expected to exceed $50 billion. The economic impact will be felt for years.

Of course, some people think that earthquakes are only a California problem. Those of us who live near the New Madrid fault line know better. In 1811 and 1812, the Memphis area was rocked by three of the most powerful earthquakes in the history of the United States, earthquakes 100 to 200 times more powerful than the recent earthquake in northern California. I think people are familiar by now with the fact that those earthquakes rang church bells in Boston and knocked down the scaffolding around the United States Capitol, which was under construction at that time. A repeat of those earthquakes would of course be an unparalleled natural catastrophe.

According to a detailed study by FEMA, a repeat of the 1811 earthquake would kill almost 4,000 people in the Memphis area, leave almost one half million people homeless and cause more than $50 billion in property damage. Similar damage would take place in Paducah and in the other large cities that are near the New Madrid fault line.

Fortunately geologists tell us that an earthquake quite that large is unlikely to occur in our lifetime. However, smaller earthquakes will occur and they will threaten lives and cause a lot of damage. Scientists tell us the New Madrid region can expect a damaging earthquake on average every 90 years or so. And although earthquakes occur less frequently in the central states than out west, they cause more damage because most buildings in the central United States are not built to withstand earthquakes. Also, the area affected by an earthquake in our part of the country is much larger because the shock waves propagate over much longer distances in the East.

Just about a year ago, there was a huge earthquake in Armenia which showed the destruction that even a moderate strength trembler can cause in an area that is not prepared. The earthquake in Armenia on December 7, 1988 was smaller than the earthquake in the San Francisco Bay area this year and yet 25,000 Armenians died and three towns were turned to complete rubble. Today, we will hear more about the Armenian tragedy from an earthquake expert from the Soviet Union who has traveled here to Memphis. He surveyed the devastation and has come here today to join in this hearing by helping us to understand what happened in Armenia, why it happened and how better preparations can prevent such damage.

Of course, our buildings in Memphis are better constructed than those in Armenia, but we cannot afford to be complacent. We need to take prudent steps now to avoid a serious catastrophe later.

The earthquake in northern California provided convincing proof of the effectiveness of earthquake preparedness. Californians have been preparing for earthquakes for more than 50 years by building earthquake resistant buildings, bridges and highways and by preparing emergency response plans. The real story in the Loma Prieta earthquake is not that homes in the Marina District collapsed and burned. It is that millions of buildings remained standing. The real story is not that the Bay Bridge had to be closed, it is that most of the other major bridges in the area were still intact and ready for traffic.

Another witness today is from northern California and he will discuss what lessons have been learned from the recent quake there and whether they can be applied here in Memphis.

The issues and choices here are not always easy. There are many thorny questions that need to be answered at the state and local level, often without having all of the data we would like to have. Should we strengthen local building codes even if that adds some percentage to cost of construction? Do we need to pay special attention to the safety of schools where so many of our children might be trapped? What should be done to protect natural gas pipelines, electrical power lines and highways to make sure they do not fail during an earthquake and become major hazards themselves?

The Federal Government can and ought to help answer these questions by funding research to help improve our scientific understanding of when and where devastating earthquakes will strike. It can provide and does provide financial assistance to help states identify particularly hazardous areas and improve emergency planning and response.

At this morning's hearing, we will try to determine the most effective ways to use limited federal, state and local resources. We will review what has been done to help prepare the Memphis area for a major earthquake, what more can be done and what the Federal Government can do to help the people of our region be ready if disaster should strike

I am eager to hear the recommendations of our local leaders and the top experts who have gathered here for this hearing. In Congress, we have worked hard to improve the federal earthquake program. We have had some resistance but we have been keeping the pressure on.

Following the northern California earthquake, I worked with my colleagues in the Senate, including most prominently Senator Ford, to provide an additional $20 million for the earthquake program. Three million of that new money is for an assessment of the threat posed by the New Madrid fault. In addition, the Senate passed legislation introduced last May in our Subcommittee to strengthen and expand the program.

The information we receive here will help Congress and the federal agencies improve our programs to help the Mississippi Valley and the nation prepare for these infrequent but inevitable disasters. We have a distinguished set of witnesses this morning and I am going to welcome them individually in a moment, but before doing that I want to say, as I said before, that I am particularly honored that Senator Wendell Ford of Kentucky is here this morning and I want to recognize him for his comments.

OPENING STATEMENT BY SENATOR FORD

Senator FORD. Thank you, Mr. Chairman. I am pleased to join with you today in reviewing earthquake preparedness in Tennessee, Kentucky and the rest of the 39 states that lie in regions classified as having major or moderate risk for earthquakes and other natural disasters.

I have the good fortune of serving in the Senate with the Senator from Tennessee and serving on the Commerce Committee with him. We have joined on many occasions to promote legislation and issues in the Senate. One of our most recent activities has been adequate funding for earthquake research. I am pleased to join with my good friend today on this important issue to both our states.

I am most concerned about education and public awareness. We have evidence through newspapers and eye-witness accounts that during the winter of 1811 and 1812, three earthquakes occurred in the Mississippi Valley. These three earthquakes are thought to have been in the range of 8.4 or higher on the Richter scale, which didn't exist at that time. We must prepare the public in those areas of the earthquake risk.

Most of the statement that I have complements what Senator Gore has said.

Where mitigation steps are taken and the public prepared for earthquakes, the loss of life, the injuries and the property damage can be reduced considerably.

Our biggest challenge in Kentucky and the Central U.S. is systematically implementing a program to ensure that the next generation of buildings and facilities we construct can withstand the impact of the earthquake which we expect to happen in the next half century.

This is a challenge which both government and private entities must take seriously.

In Kentucky, we are already doing something about that challenge. Ours is the only state in the Central U.S. with a statewide building code that includes seismic safety provisions for new buildings in the most-earthquake-prone parts of the state.

But we must also examine existing structures to determine what cost-effective mechanisms may be available to strengthen these structures.

Again, we in Kentucky hope to do something about that, too. A study of the roads system in Western Kentucky near the New Madrid Fault had identified over 100 bridges on priority routes that need seismic strengthening. The state Transportation Department is recommending that such work be undertaken to mitigate the disruption of emergency traffic after a major earthquake.

Kentucky, has had a Governor's earthquake advisory panel since 1983; the panel has made numerous recommendations in the area of public education and earthquake preparedness which we think will make a difference when an earthquake strikes our area.

Notice that I said "when," not "if." We are firmly convinced of the inevitability of a major quake in the Central U.S. affecting Kentucky and her neighbors. That's why we have taken the threat seriously and done something about it.

But much is yet to be done.

For example, we need to know more about the patterns of earthquake occurrences in the Central U.S. if we are to ever come close to predicting where, how strong and perhaps even when they will occur. A University of Kentucky seismologist, Dr. Ron Street, has a seismic network monitoring all the small and large quakes happening in the Kentucky area.

Yet to get the best possible seismic information, he needs newer equipment and, of course, the money to purchase and set up such instruments.

Congress and the Administration must provide leadership in the mitigation arena. In this respect, the Executive Order on Seismic Design for New Federal Buildings can serve as an example of the Federal Government's commitment to reducing the impact of the earthquake hazard.

Mitigation is a long-term process. Yet there are steps we can take to address the problems inherent in an intergovernmental response to an earthquake.

FEMA's support of the Central U.S. Earthquake Consortium—or CUSEC—is vital to establishing a coordinated response to an earthquake in this part of the country.

FEMA and other agencies can do more, however, to improve the capability of states and their communities to respond to an earthquake.

For example, my colleague Senator Gore has focused on the need to improve the application of information technology to the needs of emergency managers. California's October earthquake demonstrated the shortfalls in assessing the disaster's extent and communicating the information to decision makers. This problem will be compounded in the Central U.S., because major earthquakes here will almost certainly affect more than one state.

I believe FEMA should become more aggressive in the training area. For instance, Heavy Search and Rescue—involving the search for living people under the rubble of collapsed buildings—is an area which sorely needs to be addressed across the nation.

In Kentucky, the Governor's earthquake panel has recommended that we hold a school to teach those who will respond to the scene of collapsed buildings how to search for survivors without threatening their lives. But because we have no heavy rescue expertise in our area, Kentucky will have to search elsewhere for the people to conduct such a class. We will begin by calling on FEMA first.

Finally, I would like to voice my support for the International Decade for Natural Disaster Reduction.

The premise of the Decade is the belief that in spite of the knowledge, research and technology available to reduce the impact of disasters, we continue to see damage, casualties and economic losses resulting from natural disasters escalate.

The Decade offers an opportunity to address disaster reduction in a comprehensive manner. There are professions and disciplines which need to be fully integrated into the disaster preparedness process—groups like the financial sector, the insurance industry, trade groups, officials from universities and others.

The key to the Decade is to bring these groups into the process; to identify specific projects and programs that can advance the Decade concept; and to raise the priority of disaster reduction at all levels of government.

We don't have to wait until another earthquake disaster happens to take the steps to reduce the suffering and losses that earthquakes will bring.

Thank you, Mr. Chairman, for this opportunity to speak to you about a major concern in my state and the rest of the Central U.S.

I want to make one final point that is significant to my state.

I recently heard testimony before the Senate Commerce Committee with you that any repetition of the three New Madrid earthquakes would bring at least 4,000 deaths, many more injuries and tens of billions of dollars worth of damage. As a Kentuckian, I am aware that the devastation would be spread across a wide area in west Kentucky. I understand that earthquakes on the east coast are thought to extend their force ten times further than in California because of the makeup of the Appalachian bedrock.

The Federal Emergency Management Agency has estimated that the impact of a major earthquake along the New Madrid fault and the projections for Paducah, Kentucky alone are very disturbing. With an earthquake of the magnitude of 7.6, there would be 47 deaths if the earthquake occurred during the night and 116 deaths if it occurred during the day. Thirteen thousand plus people would be homeless and there would be over $4.4 billion in damage. For an earthquake of 8.6 which would be closer in size to the three New Madrid quakes, there would be 102 deaths, more than 22,000 homeless and property damage of almost $6 billion.

So Mr. Chairman, there must be real concern. I want to compliment my Kentucky folks if I may. We have building code provisions on earthquakes, and we have a hospital near Fulton, Kentucky that is built to the code, which I think is one of the few, if there are any others, that is built to that code. So we are making an effort, particularly in west Kentucky. Hopefully that enthusiasm will be extended to other parts of not only Kentucky but other states as well.

And I thank you again for the opportunity of being with you here today.

Senator GORE. Thank you very much, Senator Ford. We have got a lengthy witness list today, and I am very grateful to all of the experts who have come to join us here.

Our first panel, appropriately, is made up of the Mayor of Shelby County and the Mayor Memphis. I want to welcome both as friends and thank you for appearing here and getting us off to a good start. We will begin with Mayor Bill Morris, Mayor of Shelby County.

STATEMENT OF WILLIAM N. MORRIS, MAYOR, SHELBY COUNTY, TN

Mr. MORRIS. Thank you, Senator Gore. Mr. Chairman and Senator Ford, it is certainly good to see you again, sir, and all of the subcommittee that has been involved in these hearings before.

Let me say that those of us in Shelby County are grateful to you, Senator, for convening this special hearing in our community as we continue to plan for the day when those of us in Memphis and Shelby County are going to be faced with the results of a destructive earthquake. In particular, Mr. Chairman, we are grateful to you because you have served so well in the United States Senate this community and your interest in this area has been proven once again by the fact that you are having these hearings in this community.

During your term as a U.S. Senator, you have shown an unusual understanding of the scientific and technological currents that are transforming our society. This subcommittee has demonstrated a similar sensitivity to these issues and that is why we appreciate today the opportunity for you to apply your knowledge, your resources and your expertise to life along the New Madrid fault zone.

I must say to you and to all that are here today that since the San Francisco quake, Memphis and Shelby County have undergone a flood. It has been a flood of words, a flood of opinions, a flood of emotions.

For example, we have heard an official of FEMA give Memphis a D-plus or a C for earthquake preparedness. We heard an official of the National Bureau of Standards say that our preparedness is more like that of Soviet Armenia than northern California.

What I believe we need now is a restrained, orderly examination of the issue and an equally orderly, methodical approach to laying plans for our future, and that is exactly what Memphis and Shelby County have been doing.

Let me make one thing abundantly clear. This community did not suddenly wake up on October 17 to the revelation that we are living with the imminent threat of an earthquake.

To us, the scenes on television were not just a disturbing tragedy half a continent away. Rather, to us, they were a warning and a glimpse of our own future. Because of our proximity to the New Madrid fault, we know that we do not have to wonder whether or not we will have an earthquake, it is just a matter of when we will have an earthquake.

As a result, the San Francisco earthquake did not trigger our action. It has, however, added urgency to efforts that were already underway in this community.

We have the benefit of extensive studies forecasting damage to our city. For example, an earthquake with a magnitude of 7.6 would render most of our interstate highway system as impassible. It would probably close at least one of our two Mississippi River bridges. Most major roads serving Memphis would suffer major damage, crippling any system of transporting the injured and emergency personnel.

Damage to buildings in this community would amount to more than one billion dollars, conservatively speaking, but more importantly, if the quake occurred during day time hours, 10,000 people would be injured and 2,500 people would be killed. But most alarming of all of this, two-thirds of the fatalities would be students trapped in collapsed school buildings.

To channel the sense of urgency that followed the San Francisco earthquake into a constructive plan of action, we assembled a special county task force to review all that we were doing as a county government to plan for an earthquake, to step up the pace of our work and to begin a new effort to examine the impact which an earthquake would have on critical county services and infrastructure.

The task force includes the county Chief Administrative Officer, the Memphis and Shelby County Office of Planning and Development, the Metropolitan Planning Organization, Memphis and Shelby County Construction Codes Enforcement Department, the Roads and Bridges Department, Engineering and Public Works. In addition, we have involved the Memphis Light, Gas and Water Division, private engineers and the school systems.

The first item on our agenda was passage of the seismic safety provisions which were being considered for the new building code for Memphis and Shelby County. The complete update and rewriting of the code began four years ago and during the past two years in particular, much of its focus has been on the question of seismic design, keying on the decision about which zone we should be placed in.

The current building code calls for Zone 1, and everyone in this county agrees that it is inadequate for a new code. A few would argue that Memphis should be in Zone 3, but there is no dispute that we should be at least Zone 2. The Building Advisory Committee, appointed by Mayor Hackett and me to recommend changes in the code, conducted extensive hearings before suggesting that we settle on Zone 2.

Because the New Madrid fault has not received the same attention and study as the California fault zone, its boundaries are arguable at best. In fact, in a meeting here a month ago, U.S. geophysicist Bob Hamilton said current knowledge of the New Madrid seismic zone is comparable to the knowledge of the San Andreas zone in 1906.

As a result, it does not seems that the question about our zone will be resolved simply or soon by the scientific community, and rather than wait for the scientific data to be gathered and analyzed so that the fault zone can be pinpointed accurately and conclusively, I will be recommending to our county government in the next several days passage of the new building code which includes Zone 2 with a Z factor of .333.

This does not mean, however, that the code cannot be changed. To the contrary, development of building codes is an evolutionary process and nothing is being written in concrete. If scientific consensus shows that Memphis should be in a different zone, I would immediately support an amendment to that code.

Meanwhile, we have begun a process to consider the retrofitting of existing public buildings. It is my view that we must evaluate the ability of every school, every governmental center and every hospital to withstand an earthquake and we then must develop a program to ensure that vital public services will continue to be delivered when they are most needed, and that is after just such a disaster.

To assist us in county government, we have hired Dr. Kenneth M. Hall as a consulting engineer, and he has already begun his work. His task is to determine the effects of earthquakes on these buildings, determine the subsurface foundation condition, determine if liquefaction would occur and determine the cost of retrofitting the buildings to seismic safety standards.

In the next several weeks, Dr. Hall will evaluate the seismic safety of the Regional Medical Center, the Shelby County Administration Building, City Hall, an older city school and a newer county school. Once this information is gathered, we will be able to map out a comprehensive strategy that deals with the retrofitting of all public buildings deemed necessary.

In addition, I have issued an executive order requiring every new building, all new roads or any project considered by Shelby County government to have a seismic note that would suggest its earthquake resistance rating and the cost of improving those plans so that it will have the ability to withstand seismic stress.

But, I think we should do more though than just say what is right. We need to do what is right. That is why just a few days ago, we instructed architects designing a new misdemeanant center in Shelby County, a 1,200 bed prison facility, and a new detox center for county government, to incorporate seismic design into these plans, increasing the cost of construction for this facility by 12 to 15 percent.

At the same time, the Metropolitan Planning Organization will undertake a study to identify roadways that are critical for emergency use. It would of course be desirable to build the entire transportation system to withstand an earthquake of significant magnitude. However, realizing the funding limitations, I believe we must first begin with the critical links. Our work will focus on streets and bridges needed to get injured people to hospitals and needed by emergency units and utility crews.

The M.P.O. will identify these critical transportation links, determine the potential for disruption and estimate costs for improvements. It will set priorities for its work and send recommendations for the capital improvement budgets of local governments.

Retrofitting buildings, bridges, and roads will not be a simple short-term process. We believe it will take more than 30 years to accomplish what needs to be done, but indeed we will have a beginning.

Building codes and retrofitting are the major priorities for those of us in county government and will complement the work on preparedness that is being done by Memphis and Shelby County emergency management services. Also, we have joined with city government in supporting Memphis State University's proposal for a seismic research center and emergency facility. I am certain that you will hear more about both preparedness and research as these hearings proceed.

In 1811 and 1812, when the devastating earthquakes along the New Madrid fault shook this entire section of the country, there were few witnesses to this unleashed power, except for the Indians.

The Chickasaws reported that the earth rolled like water and that no one could walk barefoot because the ground was too hot. And according to their legend, it took place because one community of Chickasaws ignored a warning from the creator. As a result, this particular tribe was buried at the bottom of Reelfoot Lake when the earth sunk and the area filled with water.

Well, we too have had our warning and in fact Memphis and Shelby County are heeding that warning. We are now making sure that there are never any legends told about the unprepared in Memphis and Shelby County, of over-confident people who failed to prepare for the earthquake they knew would come.

If we have been guilty in this community of anything in the past, it is our lack of urgency. I believe that has been cured.

In recent weeks, we have engaged in productive discussions and our conversations now include words like Z factor, body wave magnitude, viscosity, particle acceleration and liquefaction.

But I believe we have done a great deal more than just improve our vocabulary. We have improved public awareness and regional understanding of the challenges that lie ahead.

We are now actively and aggressively planning for the day when the rest of the nation will undoubtedly look to Memphis, and we are going to make certain that in this community they will see a city that was ready to meet the test of a major earthquake.

Mr. Chairman, we are grateful for your interest, and more importantly, for your helping us prepare our city for the day when the New Madrid fault will shake again.

Thank you.

Senator **GORE**. Thank you very much, Mayor Morris, for a very impressive statement. We will hold questions until after Mayor Hackett has concluded his statement.

Let me just interject at this point to say that one of the principal purposes of this hearing is to make certain that the appropriate Federal officials in FEMA and elsewhere clearly hear and understand what local officials here are saying and have been saying so that the Federal Government will better respond to the message that you are delivering here. We appreciate the chance to hear it.

Our second witness is the Honorable Richard Hackett, Mayor of Memphis. Dick, thank you very much for joining us, and please proceed.

STATEMENT OF RICHARD C. HACKETT, MAYOR, MEMPHIS, TN

Mr. **HACKETT**. Thank you very much, Senator Gore and Senator Ford. Let me thank, as Mayor Morris did, both of you for taking time out of your schedules to afford both us this opportunity and our entire community this opportunity speak to your emergency preparedness and planning committee here.

I would be remiss too if I did not say a very special thanks to Jeff Crenshaw, the Director of Emergency Management for the City of Memphis, and his staff and the other men and women that are representing emergency services throughout this country and the citizens of Memphis who have participated and continue to participate in helping our community become better prepared. We thank you for your commitment to the people of this city and this country.

Senator Gore, Senator Ford, as you know, I led a delegation of research and emergency professionals to the San Francisco Bay area following the October 17 earthquake. I was extremely impressed by the federal, state and local agencies in the manner in which they pooled their resources in rescue and recovery efforts to minimize the effects of that disaster.

And as I watched and listened, I came away from that experience optimistic, extremely optimistic, that we in Memphis are on the right track. We are preparing our emergency and operational plans very well. But I want you both to know, and I want this community to know, this effort is not a new one in Memphis. Last year I strengthened the Emergency Management Agency and challenged its director and the entire staff to take a more active role in preparedness planning. That agency has responded and responded well by working with other government agencies and private industry to develop a workable plan.

Natural disasters are not new to this region. We here have lived under the threat of tornadoes and earthquakes for many, many years. We live with that threat year-round.

My point is, our emergency preparedness plan must and does account for every type of natural disaster and even some not-so-natural disasters like mishaps involving hazardous waste materials and of course industrial accidents.

But I know our focus today is on earthquakes, and although I left San Francisco optimistic about our emergency preparedness plan here in Memphis, I must tell you, I am much less optimistic about the effort to educate our citizens.

Oh, we have had a lot of education since the October 17 quake. All of a sudden, all of us have realized that there is a threat here in our city. And almost every day we are awakened in the morning and most of us go to bed at night learning about earthquake potential and what is being done by government to minimize the threat.

This is good, I am not complaining. This helps us in our preparedness efforts. It keep preparedness top of mind. Our challenge now is to find ways to continue this educational process. And although media must continue to play a major role, we must also encourage schools, business and industry, community and neighborhood groups to get involved.

The Federal Government must also play a hand in this vital educational process. Of the millions and millions of dollars in federal money that is allocated to this city for various projects, zero dollars—no money—no money at all is allocated to the City of Memphis for earthquake education. No federal money filters through the system to the local level to establish an earthquake education program, not a dime.

Now I understand that some $42,000 in federal money has been allocated through the Tennessee Emergency Management Agency for the entire State of Tennessee, $42,000 for the entire State of Tennessee for earthquake education. That is hardly enough money to hire one staff person.

Further, I understand that $3.5 million was recently allocated by Congress for local governments to use for earthquake education. Unfortunately, the mechanism for disbursing that money has not been put into place. That money is urgently needed, not only by us here in Memphis, but by local communities across the country. Therefore, today I would like to recommend that Memphis become an entitlement city, just as HUD disburses their funds to entitlement cities, so can FEMA.

In my opinion, education is the key in the preparedness plan. Education is the key to reducing loss of life and property in the event of a disaster. And I cannot make this statement strong enough—more money simply must be allocated and those allocated funds must be able to reach the City of Memphis and other cities throughout this country.

But I am not naive enough to think that money is the only answer and is our only need. There are some things that all of us can be doing right now in our offices and our factories and our homes to minimize the risk in the event of an earthquake, and I think it can be done at a relatively low cost. It is called non-structural mitigation.

What that means is ceiling tiles, filing cabinets, computers, bookcases, can all be fastened more securely so they do not fall when the building shakes—not if, but when the building shakes.

Government should initiate partnerships with private industry to develop and promote non-structural mitigation programs that can be carried out throughout the affected areas. However, it takes money to get this information out, money that we have not seen yet in Memphis.

Now regarding building codes, seismic design has been debated by developers, engineers and architects and researchers in our community for almost two years now. The legislative bodies of city and county governments will soon review and I hope approve the recommendation and may even recommend that they strengthen their recommendation.

It should be remembered that these codes will ensure that our children and our children's children will live and work in buildings designed to better withstand the effects of a major earthquake. For today, our efforts must be focused on preparedness. And to be better prepared, we need the necessary research, the necessary information that is updated and integrated in our planning process.

That is why in July of this year, I proposed that an all-hazards reduction center be created. The concept is straight-forward. Bring research and application under one roof to educate, to prepare, to plan and to operate in the event of a disaster.

The proposed center will house Memphis State University's Center for Earthquake Information and Research, the Memphis Office of Emergency Management and other appropriate federal agencies. This project must be jointly funded by federal, state and local governments as well as participation from the private sector.

If you have been downtown recently—and I hope the route that brought you downtown took you along Riverside Drive where you can see the tremendous development of the riverfront that is now taking place. Besides creating 20 additional acres of green space along this beautiful Mississippi River, the project is designed to stabilize the river bank. In other words, to prevent a natural disaster.

This multi-million dollar project is the result of a partnership, a partnership between the U.S. Government, the Corps of Engineers and the City of Memphis. Working together, we have been successful in providing tangible results. We have stabilized the threat, we have even reduced the threat, and created new opportunities and amenities for the people of Memphis.

That is the same partnership, that is the same kind of partnership that I am seeking in the all-hazards reduction center proposal. If we work together with a mandate to provide accurate and understandable information, we can succeed in reducing the effects of the disasters when they hit our city.

Imagine, a center where all natural disasters are studied and researched and at the same time emergency plans and operational procedures are being readied, refined and updated.

Imagine, this center dispensing information to schools, community groups, government agencies, business and industry in a massive educational process.

Now, imagine this information and expertise available not only to us here in Memphis, but to the citizens of Jonesboro, Senatobia, Carruthersville, Dyersburg as well as Washington, Dallas, St. Louis and certainly our friends in Kentucky. As you know, natural disasters know no state lines or boundaries. And with the telecommunications technology, this information can and will be shared with cities throughout this country.

It is my hope that this center will take the lead and become the model in the Federal Government's plan to make the 1990s the decade for natural disaster reduction.

Now to summarize, I again say I left San Francisco optimistic that we are on the right track here in Memphis in preparing our emergency and operational plans. What I am not optimistic about is the way disaster education is being administered and received by this community. This all-hazards reduction center makes a statement, a strong statement to this community, to this region, to the entire country, that lives and property can be saved if—and this is a big if—if we are prepared.

Armed with the right information and knowing what to do in the event of a disaster are the only responsible approaches. We have got to start the educational process now to make the citizens of our area know what steps to take to protect their families and their properties.

Senator Gore, Senator Ford, I urge you to carefully study the proposal to create this all-hazards reduction center and as you consider what is being said here today, I hope you will work with us to investigate all possible funding sources to make this necessary facility a reality.

Your presence here today signals not only to us but to all your concern and your commitment to our exhaustive efforts to ensure that our communities that we represent, and this entire region, is readied in the event of a major disaster.

Thank you for your commitment to this United States.

Senator GORE. Thank you very much, Mayor Hackett.

I want to again thank both of our witnesses on this panel.

Let me say also that Representative Mike Kernell, State Representative from Memphis, is present and took the step of inviting a number of other state legislators to attend. Mike, are you——

Mr. **Kernell.** I know we have Representative Guy Caw, State Representative Don Hume from Indiana. We also have State Senator Steve Sharp from Missouri. Are there any more legislators?

Senator **Gore.** Well we want to welcome the state legislators from the states represented here, and Mike, thank you for taking the initiative in inviting them.

Mr. **Kernell.** We also have Senator George Guerier from Mississippi.

Senator **Gore.** Great. Senator, welcome.

Thank you very much and thanks to all of you for your interest. I only have a very brief couple of questions for this panel. I know that both of you are very busy and engaged in running the county and the city, and we will not keep you here. But again, I really appreciate you coming.

I agree with the statements made about not enough money being allocated by the Federal Emergency Management Agency for earthquake education. I think that that is a good suggestion and one that we will carry back with us from this hearing. It is a suggestion we have made before, and this hearing will help to underscore the importance of it.

Just a little over three weeks ago, in getting some additional money appropriated. It is true that the mechanism has not yet been put in place, but we are pushing the administration to move forward on that and in fairness to them, they have only had a little over three weeks to do that. So I still have some confidence that they will be handling that.

I listened carefully to the comment about the FEMA official who gave the Memphis area a poor grade on earthquake preparedness and I certainly understand that reaction. One of them who testified in another forum in Washington gave a poor grade to the entire central United States. He was not singling out Memphis, but he said that a scale of 1 to 100, he would give San Francisco a 90 and he would give Armenia a zero. I do not want to hurt the feelings of our witness from Armenia, I am just quoting somebody else. I will say the same to Mayor Morris and Mayor Hackett also——

Senator **Ford.** He is trying to get diplomatic now.

Senator **Gore.** That is right. If I get in too much trouble, you bail me out now.

Senator **Ford.** You are on your own.

Senator **Gore.** What is that old saying, when you are in a hole, stop digging?

Anyway, he gave San Francisco a 90, Armenia a zero and the central U.S. a 10. Now bearing in mind that that covers an area far beyond Memphis, would you think that would be fair and accurate, and if not, what should it be? How can we get the federal agencies to do a better job of focusing their assistance throughout the central U.S. and not just paying attention only to California?

Mr. **Morris.** Well I think, Mr. Chairman, that I am not so much concerned about somebody else's grade on what we are doing in this area as I am concerned about whether or not we have this coordination that is going to be so terribly central between the federal, state and local governments of those states that are particularly involved in this area. And I think Mayor Hackett's suggestion is exactly on target. We need to have a closer liaison and I believe that the center that could be developed at Memphis State University, all under one roof, to deal with these issues in a much more coordinated way, could be helpful.

At the same time, I think there is going to have to be a great deal more emphasis given to the scientific community's ability to determine just how much impact each of these respective areas would have, depending on what kind of an earthquake we would have.

There is a great deal of confusion in the scientific community on what zone, for example, Memphis and Shelby County should be in, and perhaps other areas. It is going to be terribly difficult for this community to prepare adequately unless we have some understanding of the impact of a quake in this area, depending on the rating, so to speak. We can build codes, create codes, we can enforce codes and we can spend a great deal of money. It certainly would be helpful to know that we were spending money in the right direction and under the proper circumstances. And that is going to require somewhere along the line that the scientific community be given the assets to make certain that they have enough manpower and equipment to do a more adequate job.

I would hope that we could formulate a much closer relationship with the organizations that are responsible for providing and disseminating the information relative to earthquakes.

Mr. HACKETT. Well Senator Gore, Senator Ford, I would have to say that I probably personally and professionally am not as offended as maybe others in the community might be, having to deal with a grade that is not a passing grade. The truth of the matter is, this gentleman that made this statement is a professional and the other professionals in emergency preparedness planning are individuals that I have a great deal of respect for. But if that statement has caused us to get off of our seat and to look at ourselves and maybe even give ourselves a grade, we cannot help but say that it was a statement worth making. I do not think this gentleman or others in this field of preparedness and planning go about the country looking for a city and a community to criticize. I think it was probably a statement that indeed has shaken this community and has caused us to look harder at what we are not doing, and I think as a result of that, we are smart enough and I think experienced enough to know that it is time that we have got to do something if we are concerned about being criticized publicly. I am not so much concerned about being criticized as for us preparing for the disaster, I just to not want to fail the test when the disaster comes.

What we need to do is take heed to what this gentleman said and not get so upset about what he said but do something about it where he will not have that opportunity in the future to say it.

Senator GORE. Just one further comment on that controversy the FEMA official started. Senator Ford and I and others from our part of the country have been saying for years to FEMA that they maybe get a passing grade in their efforts where the California fault line concerned, but where the central and eastern United States is concerned, that is not the case. It is understandable because in California, the earthquake risk is a little bit different and memories are still very fresh of the damage that has occurred there. The frequency of the big quakes in our part of the country is less, even though the damage expected is greater, so memories are not fresh because there were no large communities here when the big quakes hit.

So it is understandable how FEMA would pay more attention to California than our part of the country. But one of the main purposes of this hearing is to underscore for them that our local officials and our citizens are ready and interested in focusing the kind of effort that is appropriate for the kind of risk that we face. We need an appropriate level of assistance from FEMA and the USGS and the other agencies that deal with this.

Several weeks ago, Dr. Arch Johnston and Jeff Crenshaw briefed me on the proposal for the new earthquake center at Memphis State. I think it is a great idea and I will do what I can to make it a reality.

Of course it will take money. The price tag, as I understand it, is $13.5 million. Is that correct? To put it in context, FEMA's total budget for earthquake preparedness nationwide is less than half that, and the total budget for the earthquake program is about $65 million.

But I think that this center is an excellent idea and could provide a way to focus the appropriate level of activity and preparedness here in our part of the country.

Senator Ford.

Senator **Ford**. Thank you, Mr. Chairman.

Mayor Morris, you pointed out in your statement that two or three new county buildings were being constructed to meet certain standards——

Mr. **Morris**. Right.

Senator **Ford**. And the increase was I believe you said 12 to 15 percent. Can that be a rule of thumb?

Mr. **Morris**. We think that it can be generally. These buildings are special use buildings that will house 1,200 people 24 hours a day.

Senator **Ford**. Right.

Mr. **Morris**. Consequently they will have to be built a little bit more stringent. There are those who would suggest that the rule of thumb should be more like five percent, depending on the kind of construction, such as schools. In road and bridge construction, you are talking about perhaps even less on a percentage basis, depending on the kind of construction. So a rule of thumb is very difficult to come by, depending on the use of the building itself or the project itself.

Senator **Ford**. Mayor Hackett, you intrigued me with your center. Is $13.5 million going to be in the ballpark? Is that the full amount for building the center, and what will its annual budget be?

Mr. **Hackett**. The 13 or so million dollars, Senator, would be for the capital investment to construct the facility. And I have offered in this statement that the city and local governments would participate with the state. What we want to do is set the tone for this country to help tell our story. I used an example when I was in California that we are at a distinct disadvantage here compared to those in California where they have that constant reminder called a tremor and that constant ad. That is a strong educational tool that we do not have and we are going to have to compensate ourselves for not having those tremors and it might be a little bit more expensive, and I agree it is a lot of money. But if we are willing to step forward, I think we can use that center to help reach and educate others throughout this country. With our satellite capabilities and the technology that we have here in Memphis, we can have uplinking and downlinking to other communities and use this as the educational center for the parts of the country that need to have that constant reminder. So that is where we are coming from, Senator.

Senator FORD. One other point you made in your statement was about entitlements. On what basis would you allocate them? Would you use something we are using now or would it be something different? You know, all states are not the same when it comes to earthquake risks. What kind of formula would you use for the entitlement program?

Mr. HACKETT. I think it would be wise to yield to the technicians on a question like that, but I could certainly——

Senator FORD. You are the technician, you are down in the real world where the real problems are and people get to you easier than they do Senator Gore and I.

Mr. HACKETT. Well I am always glad to hear a Senator say that.

Senator FORD. Well it is true.

That is true, it is true. That is the reason you call me and say help.

Mr. HACKETT. I think there are a number of criteria that could be used, some of which could be the population, the affected population, what cities are at greater risk and how large are those cities. Obviously, Memphis is being told constantly by the professionals in research and information particularly here at Memphis State that we are at greater risk than any other city in this region, any other area in this region. So I think when you put that kind of factor into the formula, you would have to say those larger populated areas that are more apt to have a larger loss of life would have to receive greater weight through the funding formula.

I do not want to speculate on what other criteria might be used, but when you look at the City of Memphis and see its size in comparison to the state, when you see the manner in which we are getting funds now—and I am just now talking about the federal funds having to do with FEMA, I am not talking about the other issues—I could but I am not. It just does not work out right, it does not work out well at all when we are at a much greater risk when it comes to earthquake preparedness and earthquakes in our community than any other part of the state, and we are just not receiving the funds. We cannot even hire one employee with the money they give us. And the money they do give us is for attack preparedness, not for earthquakes and tornadoes. And that is an important point to point out. We have got to, in this country, understand that we have got to deal with all hazards and it cannot just focus on earthquakes or tornadoes or attack preparedness. We have got to be prepared for whatever the disaster is and we have got to broaden our mind a little bit.

Senator FORD. Thank you, Mayor. Thank you, Mr. Chairman.

Mr. **Hackett**. Thank you, Senator.

Senator **Gore**. Thank you.

We do have some tremors, they are generally pretty light, but——

Mr. **Hackett**. Every day, but we do not feel them.

Strike that from the record.

Senator **Gore**. All right.

Mr. **Hackett**. Thank you both, gentlemen.

Senator **Ford**. Thank you, Mayor.

Senator **Gore**. Thank you, Mayor Morris; thank you, Mayor Hackett, we appreciate you getting us off to a good start.

Thank you.

On our next panel is Dr. Valeri Alekseevich Anikolenko, Vice Chairman of the Joint Council for Seismology and Earthquake-Resistant Construction in the Soviet Union's Academy of Sciences. He has traveled from Moscow for this hearing. He is joined on the panel by Mr. William Medigovich, State Director of Emergency Services in California with the Office of Emergency Services.

Thank you so much for joining us, both.

I had an opportunity to fly down on the airplane this morning with Dr. Anikolenko and we got to know each other very well. I am very pleased to welcome you to Memphis. I might say for the record in introducing this panel, that the earthquake in Armenia just a year ago was actually a little bit smaller in its power than the earthquake in San Francisco this fall. And we will be learning about the effects of both earthquakes from these witnesses and the panel this morning.

We will start, Dr. Anikolenko, with you. Welcome and thank you for being here.

STATEMENT OF DR. VALERI ALEKSEEVICH ANIKOLENKO, VICE CHAIRMAN, JOINT COUNCIL FOR SEISMOLOGY AND EARTHQUAKE-RESISTANT CONSTRUCTION, U.S.S.R. ACADEMY OF SCIENCES, MOSCOW, U.S.S.R.

Dr. **Anikolenko**. Thank you, Mr. Chairman, Senator Ford.

The earthquake in Armenia on December 7, 1988 occurred at 7:44 a.m., Greenwich time. A second shock followed it four minutes later. The first strong shock had a magnitude of about 7 on the Richter scale.

The earthquake caused severe damage and the loss of many lives in the cities of Spitak, Leninakan, and Kirovakan and in the small villages around them. Seismologists have known this area to be potentially dangerous for a long time. According to Professor Soboloff and Professor Kalesborg, two Soviet seismologists, a strong earthquake with a magnitude close to 7 or more was due to occur in north Armenia in the next ten years or so.

The map of seismic zonation of the USSR developed in 1978 and to be included in the USSR building codes in 1991, gives for this area an expected intensity of 8 and 7 in MSK scale which is close to the U.S. Modified Mercali scale. It means that in the next 50 years, one can expect an earthquake of these intensities with a probability between 5 and 50 percent. However, the current state of science does not permit us to predict reliably the place, time and the magnitude of the expected earthquake.

Every earthquake, including the Armenian earthquake, has a set of specific features which cannot be predicted before. That is why the mitigation measures required by the central and the local governments have to be given the highest priority.

This is the main lesson from the Armenian earthquake for the Soviet government and for the Soviet people. As soon as information about the earthquake came to the government of the US and the government of the Republic of Armenia, governmental commissions for the aid to Armenia were organized.

Rescue operations involved army and civil defense detachments, organizations of different ministries and agencies, as well as teams of volunteers, which however often showed poor professional habits. Emergency services of Leninakan and Spitak and Kirovakan did their work well. There were no significant leaks from gas and water pipelines and there were no fires. The telephone communications were severely damaged because many telephone poles fell down. The loss of the communications hindered our rescue operations as well as the delivery of necessary goods and equipment to the disaster area.

The electric grid was also heavily damaged. Electricity was restored seven days after the earthquake. The railway lines were also severely damaged and were not restored until 15 days after the earthquake.

I guess it would be better for me to show slides and comment on them.

Senator GORE. Okay. Could we cut these lights?

Dr. ANIKOLENKO. This is a map of the Spitak earthquake on December 7, 1988. Look at the scale of the map. The damaged area was not that large, approximately 100 kilometers in diameter.

[Slides shown.]

This is the data collected by a special team which examined the damage to different types of buildings in the Leninakan, Kirovakan and Spitak areas. This data shows that the large panel buildings survived as did frame buildings.

Another lesson from the Spitak earthquake—we do not yet know enough about our earth. You can see in the first vertical column, the names of the cities: Spitak, Leninakan and Kirovakan. The second column shows the earthquake hazard determined for these cities before the earthquake. The last two columns show estimates of the total number of people killed in each city and the number of people living in each city.

You can also see the differences between the expected intensities in these areas, from the map of seismic zonation of the USSR—Spitak, 7; Leninakan, 7; Kirovakan, 7—and the actual intensity from 9 to 10 in Spitak; from 8 to 9 in Leninakan, and 8 in Kirovakan. This column shows the excess intensity in grades of MSK scale.

This shows the damage to an old Armenian church. You see the tip of the church shifted in the horizontal direction. This picture shows that in the Armenian earthquake there were two components—vertical as well as horizontal.

This shows more damage to the same church.

You can see that many masonry buildings survived, while nearby buildings were completely destroyed.

This picture shows that the damage depended strongly on the location, the soil conditions, and the quality of construction.

This is an example of the collapse of frame-panel buildings. They are not very earthquake-resistant because if you damage one of the elements of the frame, the entire building collapses.

Mr. Medigovich, can you tell me which city is shown in this picture?

Mr. MEDIGOVICH. I think it is from Leninakan.

Dr. ANIKOLENKO. Yes, but it also reminds of San Francisco. This is a typical mistake in design—there are only vertical bars without horizontal reinforcement. This kind of design error caused similar damage in San Francisco.

Mr. MEDIGOVICH. I have a slide that contrasts nicely to that.

Dr. ANIKOLENKO. Yes.

This an example of a large panel building which survived. No one inside was injured.

This is another frame building.

This is a new map of seismic zonation for Armenia.

This the new map introduced just a few months after the earthquake. It was developed by our Council and shows new intensities; 9, 9, 9 and with 8 for only a small part of Armenia. This was done because we cannot do more precise studies. We needed to begin new construction as soon as possible and so we set the upper limit for construction in Armenia.

This is an example of construction of a new type of building with a very hard concrete core surrounded by concrete slabs. It did not perform well during the earthquake.

This building was tilting six degrees and had to be demolished because restoration costs were more than the cost of the building.

This is another typical mistake of designers—a very weak column. You can see the shift of the column in a horizontal direction.

This is a very good example. This is a paneled building and the rubble is from another frame paneled building. They were as you can see, quite close to one another, but one completely collapsed and the other survived intact and no one inside was even injured.

This is another example of a mistake made by the designers. You see the ground floor is very heavily damaged because the ground floor usually used for shops and shops demand more room, so the ground floor was structurally very weak.

This part of my presentation is for shock propaganda. Every person thinks that it can happen in another city, to another family and to other people. These Armenian people also thought that. You see the coffins.

The rescue operation and coffins, again.

This family, these babies, were killed during this earthquake. Look at them.

This is a rescue operation, very difficult. Coffins again.

This is an inside view of one of the flats after the earthquakes.

Senator GORE. Are those the pictures of the missing that they are trying to locate?

Dr. ANIKOLENKO. These are pictures of killed schoolboys and this picture was from the United States album prepared by Berkeley University.

Senator GORE. Thank you. Thank you very much, Dr. Anikolenko.

Thank you very much, it was a very powerful presentation. You referred to it as shock propaganda. I think it is a message of friendship for you to come here and share with us this powerful message about the pain and suffering that your country experienced in the Armenian earthquake. That you care enough to help us with our efforts in the United States to prepare for earthquakes is something that is a true act of friendship and we appreciate your presence here very much.

Dr. ANIKOLENKO. Thank you.

Senator GORE. We will ask a few questions later, but now we will hear from Mr. William Medigovich, the State Director of Emergency Services with the Office of Emergency Services in Sacramento, California. He will tell us about earthquake preparedness in San Francisco. Mr. Medigovich, we are grateful for your presence here.

STATEMENT OF WILLIAM M. MEDIGOVICH, STATE DIRECTOR OF EMERGENCY SERVICES, OFFICE OF EMERGENCY SERVICES, SACRAMENTO, CA

Mr. MEDIGOVICH. Thank you, Senators.

It is a pleasure to be here and I can thank you for the invitation. I would also like to thank you for moving so swiftly to bring aid to California, that was a remarkable turnaround of time and effort to get us the funds we needed to be able to carry out our activities out there. I also appreciate the tremendous way in which people of Tennessee and indeed the states out here have worked on this issue. We have enjoyed working with them, and as Mayor Morris had said earlier, it is not just a recent thing, they have been involved in this for some time and we have been very pleased to have supported you all in the process.

I know that we had Mayor Hackett and his group out to California just a day or so after the earthquake and they were at our office where we had an opportunity to brief them and give them some firsthand information on it.

I think before I start my slides, and I know in the interest of time, that there are some points that I would like to get across to you, and one is that you can really truly believe what the U.S. Geological Survey is telling you and your experts here at Memphis University. Earthquakes do occur and they have been right on target with their estimates out in California, remarkably so as you will see in our slides later.

The other message is that preparedness pays high dividends—there is no question about that. You can all pay a little bit now or you can pay one hell of a lot later on, as we found out in California.

I know that some of you have been new to the earthquake area, and as somebody quipped to me last night, "prior to this hearing I didn't know the difference between liquifaction and liposuction"!

But we are all becoming experts and with each earthquake we have out in California, we learn a lot more too. If I might have my slides, they are on the tray there.

Senator **Gore**. I am glad I am not the only one with corny jokes this morning.

Mr. **Medigovich**. Well I cannot beat the dog under the bed. I will carry that one back to California. Senator Wilson might use that in his campaign.

Senator **Ford**. Let him have that one.

Senator **Gore**. Yes, let him have that one.

Mr. **Medigovich**. This slide obviously shows the San Andreas fault and if you look up there, you can see, there is sort of a line in the middle and you can see the cross section, you can see how much the fault has slipped over there——

Senator **Gore**. Why do you not try that other mike. There you go.

I believe that one works better.

Mr. **Medigovich**. I will have a technological hazard here in a minute if I am not careful.

Senator **Ford**. Watch your fault.

Mr. **Medigovich**. As you can see, this is the San Andreas fault here and the slide slip mechanism that we have seen where the fault line would normally go like this, but you see it has moved all the way over, so that is dramatic evidence of what we are facing and that is the cause of our big problem out in California.

This is interesting because the fault line extends right through an area where we have a water reservoir and a highly populated area, and moves on up through the state.

[Slides shown.]

An idea of the fault line and these two areas here which had been predicted to release energy, this one being the Hayward fault line and this the San Andreas fault line. The experts are telling us that the Hayward fault on the east side of the bay maybe the next one to go and I am taking their admonition very, very seriously.

Again, you can see this area—and the difference here, these are all soft areas, this is where the land, the soil is hazardous, the yellow being fairly hazardous, the red being very hazardous, and it parallels to a great extent the populated areas. As you can see from this satellite photograph, the populated areas, the Haywood fault running through here, San Andreas on the other side there, both run through major population areas and we will have to live with this fault. This is part of the problem we have inherited due to a lack of scientific knowledge in the past.

Another dramatic view of that high potential for ground failure here.

This is in the Santa Cruz Mountain area, it is actually not the fault rupture point itself, but, part of a landslide. Major landslide problems accompanied the earthquake.

Again, one of our major highways, #17, when this slide was taken it was partially cleared, blocked highways were a major problem for us; we expect more of these following earthquakes.

This is Highway 1, you can see a dramatic view here of the undulation that took place on that freeway.

A more dramatic one shows the uplift. These concrete support pillars actually broke through the pavement, a very dramatic scene.

Senator **Ford**. Like a missile.

Senator **Gore**. You mean those were support structures that were just driven up through the pavement.

Mr. **Medigovich**. Yes, you can see the support structure here driven right up through the concrete roadway.

Again, here is a typical wood frame house, they generally perform well because they are made of wood, but older homes are not secured to a foundation, simply slip off the foundation. This is not too dramatic a view of it, but as you can see the natural gas line here, can cause problems.

Another typical example and there are many homes such as these: the fireplaces and chimneys collapse along with front porches and any overhangs.

Unreinforced masonry buildings pose a significant threat. They will collapse outward. Anybody standing nearby can be injured—in this instance several people were killed as it collapsed downward.

Another example of what Mr. Anikolenko was describing can be seen by this slide of the Marina District in San Francisco, they are so-called soft story structures. They typically build garages under them. They are not reinforced with cross members and so they tend to collapse and as you will see—yes, this is an example too. This one had a garage underneath it, it just settled right down to the ground.

There again another building. The wood structures, when they are built like that, simply collapse.

We did not have the fires we anticipated in the city thanks to good planning and thanks to Pacific Gas & Electric Company and their emergency services people, who cut off the flow gas so fires did not break out. They did not turn on the electricity or gas until they went through each area very carefully and tested it.

Here is another good example.

This is the area of the Marina district with the 1857 shoreline. You can see it clearly. As you may recall, following the 1906 earthquake, they used all the fallen building materials as fill in this area.

Here's another view. At one time there was a small lake in here. They filled it in, and then constructed homes on it. A jurisdiction needs strong building codes to ensure that structures will not collapse when built on landfill.

This slide shows you what can happen to a communications tower. A little bit higher on the Richter scale and a lot more communications structures would have been fallen down.

Again to emphasize what your experts are telling you, this was done for a scenario before the October 17 earthquake. You see the dark lines here, that is where the Cypress freeway is and where the damage occurred. This is where the Bay Bridge is and you can see the dark line indicating where they expected failure at these points and we had clearly anticipated it in our earthquake planning strategy.

Here is the Bay Bridge, damaged portion over here, and here is where the break occurred with that one part of the span.

This is what happens when soil starts to liquify and starts to percolate upwards. Eventually if liquefaction takes place, you will find that whole buildings can sink and sink very deeply.

This is a view from the Bay Bridge and you can see where that one stretch of span was sitting on a pedestal, not very wide, and how it snapped off and sheared to bring it down. That is something we need to really be concerned about, and our CalTrans people, the California Department of Transportation, has had a retrofit program in place for many years, this was one that slipped through the cracks literally.

Here is another example of liquifaction again. You are looking at the type of soil that is out there, that permeates the Bay Area. We could predict where the collapses are going to take place.

This slide resembles the slide from Soviet Armenia. A graphic example. You can see that these one and three-quarters inch bars simply snapped. A tribute to the construction however is that the bottom span did not collapse. It stayed up, not only during the earthquake, but it withstood the many thousands of tons of concrete that collapsed on top of it. So we know and our CalTrans people realize that we have good building standards for the freeways, the single span ones.

Again, another dramatic shot of that. That metal rods snapped almost like a handful of spaghetti being broken. It was a nearly simultaneous event for the whole mile and a half.

And as Dr. Anikolenko pointed out, it was not wrapped, if it had, perhaps, been wrapped with a metal casing on the outside, speculation is that it might have prevented that from taking place.

Here is an example of where we have had retrofitting. And where we did that on the freeways, they performed well. A little investment now saves you a lot later.

Some of our learning points here, lessons from the Loma Prieta. One that—the forecast, as I said, what the experts tell you is true. As an emergency response official and one involved in the recovery effort, the scientific material was absolutely invaluable.

They do provide us with realistic scenarios.

And those structures that had been strengthened, where they had been retrofitted remained standing. Older structures are vulnerable and the lesson for you people out here is, that unreinforced masonry buildings, non-ductile type of structures, will collapse. We view them as the greatest threat to life.

Search and rescue capabilities, it goes without saying, are extremely important. We have a major task we are embarking on in California to expand those capabilities. If you do not have the necessary people and the skilled teams you are severely handicapped. You have to have a coordinated team composed of medical experts, structural engineers, you have to have the traditional dog teams, and the kinds of tools and technology which in many cases do not exist, to help us rescue people a lot faster.

Often the problem is not the quantity of resources, but how they are applied. One must get the right resource to the right incident in a timely way.

Officials must understand the response system. And that goes for all levels of government—supervisors and city council people, they have to understand how the system works and the measures that their emergency managers are going to take when the problem occurs.

As we saw in Armenia and as we saw in California, the volunteers, the people in the area, become your greatest resource. You need to work with them, they need to understand how the programs work and then you have to have a cadre, you have to train with them to show how they can be utilized when the earthquake takes place.

Housing and shelter is a major policy dilemma. And as discussed last night with Grant Peterson, both FEMA, our organizations and emergency managers are going to be faced with that issue in future urban disasters. It takes more than just your emergency response people to deal with that issue. That is something that requires action on a coordinated front.

This was not the big one, but it was pretty big; we are still anticipating a larger earthquake.

Thank you. Preparedness does work. That is the last slide.

[The statement follows:]

TESTIMONY: SENATE COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION

Monday, December 11, 1989
Memphis, Tennessee

William M. Medigovich, Director
California Office of Emergency Services

OVERVIEW

The events of October 17 were not unexpected in California. For the past ten years, the State has worked closely with the U. S. Geological Survey in analyzing the seismic risk to the State and in developing, with FEMA a comprehensive program of earthquake preparedness and hazard reduction. While the death toll and property damage were tragic, without the comprehensive preparedness activities initiated by the State over the past fifty years, the losses world have been even greater.

It is important to note that mitigation of the earthquake hazards in California did not occur over night, nor is the task complete. After the 1933 Long Beach earthquake, the State initiated mitigation with passage of the Field Act to ensure that public schools were earthquake resistant. The State also mandated seismic buildings codes in every jurisdiction. It was not until 1980, however, nearly fifty years after the Long Beach disaster, that all public schools were brought into conformance with the Field Act. After each earthquake, seismic codes have been up dated and improved, providing an assurance that newer construction is seismically resistant. But, we continue to have a significant inventory of existing buildings, both those built before seismic codes, and those built to lesser codes that we now know are inadequate in earthquakes. The task of making our communities safe is both one of making sure that new construction is safe, and, more importantly, of abating the hazards that decades of non-seismic design have produced. And, achieving a seismically safe environment will not occur overnight.

Since the mid 1970s, in the aftermath of the San Fernando Earthquake, the State has played an even greater leadership role in reducing the risk posed by earthquakes to our communities, ensuring the safety of schools, hospitals, dams, and retrofitting a significant portion of our infrastructure. The Loma Prieta earthquake on October 17, 1989 is the severest and most dramatic test of our efforts and of California's preparedness.

Our most recent efforts in California have focused on two areas. We have developed, at the local level, a high degree of professionalism and expertise in disaster response. We have simultaneously, through the efforts of the California Seismic Safety Commission, and the earthquake preparedness projects of OES, pressed local governments and other institutions to reduce the hazards in their jurisdictions -- particularly hazardous buildings. The programs of OES include support and assistance to local governments through the California Specialized Training Institute and the Southern California and Bay Area Regional Earthquake Preparedness Projects. These programs provide the technical expertise and training necessary to assist local governments in building their capability to prepare and respond.

While local governments in California play a critical role in development, planning and response, OES has developed the processes and protocols to respond by bringing to bear the resources of the State and Federal government to assist local governments during disasters.

Our response to the M 7.1 Loma Prieta Earthquake of October 17 illustrates, I believe, the effectiveness of our capabilities at both the State and particularly the local level to respond to such emergencies.

Local governments throughout the impacted area responded and controlled the situation within the first hours after the earthquake. They were able to marshall the resources within their jurisdictions to meet their immediate needs, and, when necessary, requested support from the State.

At the community level, individual residents of damaged areas spontaneously responded to assist those in need of help. At the Cypress structure in Oakland, in the Marina District of San Francisco, in the central business districts of Watsonville, Hollister, Los Gatos, Santa Cruz, and on the Bay Bridge, spontaneous volunteers risked their lives to pull victims from the debris of collapsed structures. As emergency response professionals arrived at the scenes of damage, they incorporated the volunteers into their efforts to rescue victims. Californians pulled together in response to the Loma Prieta Disaster; and, I believe, our successes are directly related to our work over the years, advocating preparedness at the community, business, and municipal level. I believe this positive response was, to a great extent, a result of our earthquake awareness and preparedness programs. Our citizens knew what to expect, and how to respond.

The impact of the Loma Prieta earthquake of October 17 was predictable. Areas that were built on poor soils experienced more extensive damage than sites on consolidated soils. In the Marina district of San Francisco, both the violence and duration of ground shaking was increased by the poor soils. In the Santa Cruz Mountains, ancient landslides were activated by the shaking, setting in motion massive earth movements, some as large as 3 km long and 2 km wide. In Oakland, the catastrophic collapse of the Cypress Viaduct may have resulted from a combination of poor soil conditions and archaic concrete design concepts. Earth scientists had warned us to expect greater damage in these areas. Their forecasts have now, in dramatic fashion, been validated!

The structures that we know are vulnerable suffered the greatest damage. Unreinforced masonry buildings (URMs), brick structures built without steel reinforcement to resist earthquake forces, collapsed into themselves, onto adjacent structures and onto the sidewalks and streets in Watsonville, Hollister, Santa Cruz, Los Gatos, Oakland and San Francisco. These structures, built before 1933, predominate in most older central business districts in California as they do across the United States. They pose a threat to the lives of occupants, as well as to passersby on street and sidewalk in quakes as small as M6.0.

Damage to these structures around the Bay had life safety as well as social and economic impacts. URMs provide a vital resource of low cost housing and commercial space in older central cities. Damage on October 17 resulted in the loss of more than 2,000 single room occupancy housing units and over 180 business sites, severely impacting lower income community residents. Displacement of these residents, in communities where the vacancy rate is less than 1%, has posed a housing problem for which we do not currently have a solution.

To attempt to reduce damage to their older building stock, many communities in California now require strengthening of URMs. In these communities, damage and collapse was reduced.

Older wood frame structures, built after the turn of the century on brick foundations, without bolting or bracing of foundation walls, also suffered extensive damage, adding to the loss of low-income housing. In Watsonville, with a prequake vacancy rate of less than 1%, more that 8% of the hosing stock was severely damaged or destroyed. Prevention of this type of damage is both easy and cost effective. Unfortunately, where the cost of mitigation was, before the earthquake, in the hundreds of dollars, the losses now are in the tens of thousands of dollars. This is an area where mortgage lenders, insurance companies, and local building departments all have a stake in preventing damage, and where cost effective mitigation can eliminate losses.

The mitigation and response planning efforts of CalTrans and the public utilities proved effective during this earthquake. With the exception of collapse of the Cypress Viaduct and failure of connections on the Bay Bridge, both older structures built to older seismic codes, the retrofit of the freeway system proved its value, structures remained operational after the earthquake. Similarly, except where massive ground failure occurred, the public utilities continued to provide service with only scattered interruptions. Response capability developed within the utilities reestablished service within days to most areas. The monumental task of repairing the damaged Bay Bridge was completed in less than 30 days. In the interim, planning by the transit operators provided transbay travel on BART, ferries, and in van pools.

The collapse of a single structure, the Cypress Viaduct of Interstate 880, caused the single greatest loss of life on October 17. The catastrophic collapse of more than a mile of this non-ductile (brittle) concrete frame structure, poses the greatest challenge to Californians. We have thousands of structures of this type, both in our freeway infrastructure, and also in our more dense, urban centers, where non-ductile concrete was utilized for midrise office, commercial and residential occupancies though the 1960s. The collapse of the Cypress, presented a sobering view of the potential impact of future earthquakes, where the loss of life in the collapse of a single structure could eclipse the losses from all structural collapses in earthquake during this century. The challenge before us a this time is to move forward quickly to strengthen these structures to ensure their seismic resistance; a challenge that will determine the outcome of future earthquakes.

LESSONS FOR THE UNITED STATES

The Loma Prieta Earthquake presents a graphic lesson to those of us in hazard mitigation and emergency response planning. First, and most importantly, seismic design pays off. Structures designed and built to the most recent seismic design provisions of the Uniform Building Code withstood the forces of the Loma Prieta earthquake with little or no damage. Structures built to lessor code provisions, or in the case of URMs, contained no seismic resistance, suffered extensive damage.

The following lessons should also be clear to residents of the northeast, southeast, and central states, where the threat of earthquakes may be as great as it is in California:

1. Site conditions can be a dominant factor in determining damage to structures. It is therefore important to ensure that seismic design provisions adequately address site factors. Risk mapping of existing development on poor soils can assist both emergency responders and redevelopment planners in understanding the extent of local risk.

2. Unreinforced masonry buildings are a life threat awaiting a moderate earthquake. These structures can be cost effectively strengthen to resist seismic forces and reduce the threat they pose to life. As URMs provide a vital source of low cost housing and commercial space in older central business districts, their strengthening and preservation is essential to the economic and social fabric of our communities.

3. Non-ductile concrete structures, designed and built before the 1973 revisions to the Uniform Building Code can collapse in moderate and larger earthquakes, posing the potential for a catastrophic loss of life. These buildings should be inventoried and retrofit to withstand seismic forces.

4. The performance of schools, essential services buildings, and hospitals should be ensured through enforcement of strict seismic design and construction provisions administered by each state. These facilities are essential to our communities. The regulation of their construction in California by State agencies, provided a greater measure of safety and performance in this earthquake. It should be noted, however, that it has taken almost 50 years to bring all of California's public primary schools into conformance with the Field Act. The outcome of Loma Prieta would have been difference if the programs had not been initiated in 1933!

5. Creating a seismically safe environment will not occur overnight. Therefore, emergency response capability, including urban search and rescue, rapid damage assessment and disaster management must be in place and ready to respond. California, with the assistance of FEMA, has put in place a comprehensive program of training, support for local government preparedness and mitigation, and procedures in integrate State and Federal resources to respond to the needs at the local level. These programs and systems proved themselves effective on October 17. Without them, the earthquake could have been a catastrophic disaster. These types of systems and programs would be essential in the response to an earthquake in the New Madrid region, where hundreds of jurisdictions and several states would be impacted simultaneously.

The outcome of a seismic event is determined before the ground starts shaking. The earthquake tests our planning and development decisions, the quality of our building design and construction, and our ability to quickly respond to the needs of our citizens. We believe we have changed the outcome of earthquake events through mitigation and preparedness. Therefore, the single most important lesson of the Loma Prieta Earthquake for the central States is that preparedness pays.

Senator GORE. Thank you very much, that was a very interesting presentation—thank you.

Let me ask a couple of questions and then turn it over to Senator Ford.

Dr. Anikolenko, Mr. Medigovich said preparedness works.

Dr. ANIKOLENKO. Yes.

Senator GORE. Buildings should be constructed in high risk areas in a way that accounts for earthquakes, right?

Dr. ANIKOLENKO. Right.

Senator GORE. In the Soviet Union, is it hard to incorporate earthquake safety measures into building standards?

Dr. ANIKOLENKO. I have to say that every building standard in every country strongly depends on the economic conditions in that country. You can introduce building codes requiring very high levels of resistivity against the strongest earthquakes, but the economic conditions of the country may prevent you from implementing them.

As Mr. Medigovich described in his testimony, there is a dilemma, do you keep people homeless or do you quickly build inexpensive, weak buildings for them? I guess you understand me.

Senator GORE. Yes.

Dr. ANIKOLENKO. Excuse me for my poor English.

Senator GORE. You are doing great.

Senator FORD. I do not speak a bit of Russian, so——

Senator GORE. Thank you very much.

Mr. Medigovich, from all reports, your personnel responded very well.

Mr. MEDIGOVICH. Thank you, sir.

Senator GORE. Your state program has been complimented many times. Some have said that if the earthquake had been larger, then your local emergency personnel might have been overwhelmed. Is that your view also?

Mr. MEDIGOVICH. Oh yes, most definitely. We were very fortunate in this earthquake.

The catastrophic plan that the Federal Government has is something that would really help us in that regard and one that we trained for just prior to this earthquake. You may have heard we had a major exercise out there in August which tested the federal response system. In this earthquake we really did not have to request extraordinary resources to request a lot of the federal resources, but we anticipate that in a larger one, that we will have to have extraordinary responses and that means large numbers of out-of-state and federal resources.

Senator GORE. Sherlock Holmes wrote a story once that depended for its resolution on a clue involving the dog that did not bark. The buildings that did not fall in San Francisco represent the most important lesson from your experience there. The level of preparedness seems to be higher in San Francisco than anywhere else. I know you take some pride in that, but do you think that is accurate?

Mr. MEDIGOVICH. Well it is, but you have to break it down into what kinds of preparedness there is. It has been a difficult time for San Francisco in the past, anticipating a major earthquake, but you have to keep in mind that this was a region-wide earthquake.

It is frequently referred to as the San Francisco earthquake which really upsets our constituents down in Santa Cruz, Monterey——

Senator GORE. That were hit much harder.

Mr. MEDIGOVICH. Yes, in fact. It was widespread.

What we are fortunate to have in California is a strong infrastructure within our emergency management community and a strong mutual aid system that allows us to move manpower and resources from one area of the state very rapidly. But the program does vary from jurisdiction to jurisdiction and in many jurisdictions we do not have as strong an effort as we would like to have. We do, however, have two programs for our state that we are very grateful to the Federal Government and to FEMA for having sponsored, going back to 1980 and 1981. That is the Bay Area Earthquake Preparedness Project and the Southern California Earthquake Preparedness Project, two organizations in our office that do nothing but earthquake preparedness work, working with business and industry and the schools with outreach to the local area. And I think that kind of pattern could be followed here in this area as well and you would find that the resources and programs would reach down to the local level very well.

Senator GORE. One thing which both of you said was that even within a high-risk area, there is a great difference in the damage that occurs because of the kind of soil in different parts of the high risk area. We will ask the witnesses on our next panel about what we can learn about the soils in our area and elsewhere in the central United States and how they might respond in an earthquake.

Dr. Anikolenko, do you believe we can benefit from international cooperation in earthquake research and preparedness?

Dr. ANIKOLENKO. Yes. I believe that international cooperation in earthquake preparedness and scientific research enhances our ability to prepare for earthquakes, and to exchange new technological achievements. Maybe we can organize a way to provide mutual financial support because the earthquakes are not so frequent occur. This is my opinion and I guess it is opinion of our delegation here.

Senator GORE. Thank you very much.

Senator Ford.

Senator FORD. Doctor, do not feel bad about not speaking very good English. It is amazing how many people in other countries speak English, and yet we fail to study their language.

Dr. ANIKOLENKO. Thank you.

Senator FORD. I am bilingual, bad English and Southern.

Doctor, did I understand you correctly that the underground pipes, water lines and gas lines stayed virtually intact?

Dr. ANIKOLENKO. Yes, they survived.

Senator FORD. They survived?

Dr. ANIKOLENKO. Yes.

Senator FORD. But the telephone system and other lines of communications were devastated.

Dr. ANIKOLENKO. Yes. Telephone poles fell down and the electric grid but not the power plants, was damaged considerably. I brought a special album showing the damage to the electric grid and electrical equipment in the north of Armenia. I would like to present to the Committee and the Chairman.

[Document presented to Chairman.]

Senator **Gore**. Thank you very much.

Senator **Ford**. Doctor in your slides you showed buildings that collapsed and also buildings that withstood the earthquake. You pointed out one that had a heavy concrete structure next to another one next door that had collapsed.

Dr. **Anikolenko**. Yes. As I described before, the most of the damage and most of the deaths were in brick frame panel buildings.

Senator **Ford**. Brick panels.

Dr. **Anikolenko**. Brick panel.

Senator **Ford**. What we call brick veneer.

Well let me ask you about California for a minute. Mr. Medigovich, what do you mean when you say retrofit? I understand how to retrofit a power plant with clean coal technology, for example but how do you retrofit buildings, bridges and highways for earthquakes?

Mr. **Medigovich**. As you have learned, in California we have had programs and building codes have been put in place, usually in increments following each major earthquake and 1933 was the one that really caused our standards to change. At this point because we have so—there are still many, many, some 40,000 unreinforced masonry buildings, those that will just collapse, no reinforced metal, nothing supporting them. And there are other structures that were built to codes say prior to 1970 in which the scientists and engineers have told us, structural engineers, that new changes are needed—those buildings can be saved if a little investment is made into bringing in a structural engineer, examining the facility and learning how to strengthen them to prevent collapse. So you see quite a bit of this going on in different cities in California, they will take buildings and reinforce the structures so that they can withstand it.

In terms of the retrofit that I pointed to on the slide——

Senator **Ford**. That was on a bridge or a highway that you showed.

Mr. **Medigovich**. Yes, that was a highway bridge overpass. The Department of Transportation in California had a major program with many, many, many millions of dollars that has been underway for a number of years where they have just gone systematically throughout the state and retied and strengthened these bridges and overpasses so that they would not collapse as easy, up to about a 7.5 standard I believe.

Senator **Ford**. When you say tied, was that with, steel?

Mr. **Medigovich**. With metal, with straps, with different types of braces.

Senator **Ford**. Fairly expensive?

Mr. **Medigovich**. It is, but as you can see, when one does collapse—and we have had, like the prior earthquakes, the Whittier earthquake for example in southern California, where those structures remained in place and there was not a great deal of cost in having to rebuild them.

Senator **Ford**. How much money does California spend each year to prepare for earthquakes?

Mr. **Medigovich**. It is a significant figure. We are probably in the several million area, and it not only includes——

Senator **Ford**. We want $13 million for our building here, that is several million. What is significant?

Mr. **Medigovich**. I do not have those figures at my immediate disposal, Senator, but it is broken down into several areas. The educational part of it, we have ongoing through my budget about a million and a half yearly going in it for earthquake preparedness. The other agencies and departments also have budgeted amounts of money for it. CalTrans, for example, Department of Transportation, the hospital boards, the Office of the State Architect.

Senator **Ford**. Each is allocated so much money.

Mr. **Medigovich**. That is correct.

Senator **Ford**. What percentage, if any, is received from the Federal Government?

Mr. **Medigovich**. We receive approximately—I think it is $1.2 million yearly.

Senator **Ford**. Is that total for the whole state?

Mr. **Medigovich**. Yes.

Senator **Ford**. One point two million, okay. We would not even add that to the Gramm-Rudman-Hollings if we put that in the budget.

Senator **Gore**. That would be from FEMA alone, right?

Mr. **Medigovich**. That is from FEMA alone.

Senator **Ford**. Is that the only money that California receives?

Mr. **Medigovich**. The only federal money we at OES receive.

Senator **Gore**. What about USGS?

Mr. **Medigovich**. Oh, USGS——

Dr. **Peck**. We put several million dollars, probably three or four, as far as our own efforts, as far as grants to universities for monitoring earthquakes and carrying out investigations.

Mr. **Medigovich**. I am glad he raised that because there is money coming from a variety of sources, and even through FEMA, although their earthquake hazard reduction program monies are a special appropriation, for example in the EMA, Emergency Management Assistance funds that come into each state, they are allowed to use portions of that to—for individuals that are under that program to do earthquake preparedness as well as civil defense training.

Senator **Ford**. You mentioned the preparedness exercise that you had back in August. I know my state was there not to participate but to observe. How many states and what kind of people came to observe your exercise?

Mr. **Medigovich**. Well we had all the CUSEC representatives there and there were several other states from just outside of California, Arizona and Nevada, Washington, that participated, and some foreign countries as well.

Now we have had and have a regular program of holding earthquake exercises in California, but they had been oriented toward the state response to local incidents; this was the first time that we had a major exercise that was in conjunction with FEMA and which tested the federal response.

Senator **Ford**. I guess that every time that we have an earthquake, things happen that are not planned for. Let me ask you two questions. What were the major unpleasant surprises that happened in this earthquake, and were there any pleasant surprises, I mean those that you were prepared for and could cope with? What is the downside that you were not prepared for, and what is the upside that came off a little better than you expected?

Mr. **Medigovich**. Well on the good side, I think this was—well I know this was the fastest turnaround in which we received a Presidential declaration.

Senator **Ford**. That was after Hugo.

Mr. **Medigovich**. After Hugo.

Senator **Ford**. There is always the other side of the coin.

Mr. **Medigovich**. Certainly, sir. I can only speak from California's perspective and——

Senator **Ford**. But I have to look at it from a broader perspective.

Mr. **Medigovich**. Yes. Again, the fastest turnaround receiving a declaration and getting the disaster application centers up four days following the disaster and getting those programs underway.

The difficult side, and one that we have to have a hard look at, of course is in damage assessment and getting intelligence from the local jurisdictions. When you have a major earthquake or a major disaster, there is an incredible demand to try to get the information, the correct information so that state decision-makers and the Federal Government in tandem, can begin to know what kind of equipment and resources will be needed. And so it is really vital that we have that. Our communications flow in that regard suffered. We need to do something about that to allow for quicker movement of information from the field.

The second part of that is that you have to have an adequate capability at the local level because as so often is the case, local government is so preoccupied with the incident itself and the earthquake that they just do not have the time to report to the state and to the Federal Government on certain kinds of information that we need to make our decisions on. And so in order to compensate for that, we are going to be dispatching individuals—and they will require some training—along with individuals from different state agencies, coordinated by our office, to go right to the scene and be the hip pocket resource of the local government. In so doing we can remove that burden from their shoulders.

Senator **Ford**. I thought you would have a local coordinator that could be contacted soon after the earthquake who would be on the scene to give you their evaluation of what would be needed.

Mr. **Medigovich**. We do that, but now the training has to be very, very specific to that jurisdiction. So we are going to pre-identify the jurisdictions and send people into them immediately.

Then those individuals would know our system and our needs in reporting. And if the incident is bad enough, if the earthquake is bad enough, of course, then you could find that there may not be enough people, responsible type people, at a local jurisdiction, so we would have to compensate for that.

Senator **Ford**. Thank you, Mr. Chairman.

Senator **Gore**. Thank you, Senator Ford.

One other question, Mr. Medigovich. Is there any way to estimate what would have happened in this Loma Prieta earthquake if there had not been strict adherence to earthquake standards and if the preparedness plan had not been in effect?

Mr. **Medigovich**. I think we would have seen an Armenia situation most definitely. And those structures that are out there, they are death traps, and you need to heed the advice of your experts, however painful it is to really begin to think hard about that. There has to be recognition by the local Government and the people in the community that they need to take these measures and do them now.

Dr. **Anikolenko**. I want to add something.

I want to say that in the damaged area in Armenia it looks like there had been an H-bomb attack. All ties to the outside world, all communications were completely destroyed, people were demoralized and so on. It is very difficult to launch rescue operations and to provide sufficient supplies for people.

Senator **Gore**. Well in summarizing this panel's testimony, the earthquake in the San Francisco Bay area and south of there was more powerful than the one in Armenia one year ago. The earthquake in Armenia left damage that resembled, in your words, Dr. Anikolenko, an H-bomb attack, with devastation, 26,000 lives lost, personal tragedies which you were able to bring home to us in your eloquent presentations. Yet, an even more powerful earthquake in California killed less than 100 people, and although it caused a great deal of property damage, there was far less there than would have been had there not been extensive preparation.

A similar earthquake in the central United States would find us somewhere between the levels of preparedness in the Armenia and California locations. Where on that scale of preparedness is a matter of some controversy, but we know that we are not as prepared as we should be and we know that great efforts are needed to raise the level of preparedness.

Thank you both very much for testifying here today.

Mr. **Medigovich**. Thank you.

Dr. **Anikolenko**. Thank you very much.

Senator **Gore**. Our next panel will address earthquake preparedness in the Memphis area. We are pleased to welcome Dr. Arch Johnston, Director of the Center for Earthquake Research and Information here at Memphis State University and Mr. Lacy Suiter, Director of the Tennessee Emergency Management Agency based in Nashville.

Both of these gentlemen are personal friends, both have testified before our Committee on prior occasions, and we are delighted that both of you are here.

Dr. Johnston, we are going to go first to your statement. Let me acknowledge my own personal debt to you, I have learned a great deal from you about this subject and indeed my interest in earthquakes in the central United States comes in large part because of what you have taught me about the risks involved here. I am a big fan of yours and I am delighted that you have a statement to present to us here this morning. So welcome.

STATEMENT OF DR. ARCH JOHNSTON, DIRECTOR, CENTER FOR EARTHQUAKE RESEARCH AND INFORMATION, PROFESSOR OF GEOLOGICAL SCIENCES, MEMPHIS STATE UNIVERSITY, MEMPHIS, TN

Dr. JOHNSTON. Thank you, Senator. I in turn appreciate your support through the years for the earthquake problem. It is the view of the scientific community that you are in the forefront. I would also like to thank Senator Ford for his support. I know through Dr. Ron Street, a leading seismologist at the University of Kentucky, of the strong support he has had from Senator Ford.

In fact, Tennessee could stand to learn some lessons from our sister state, Kentucky. Two examples would be Kentucky enforces seismic provisions in their building code. And a second example is the state directly supports a seismic instrument monitoring network.

The year 1989 will have a special significance in this nation's history for at least two reasons: the sudden restructuring of Eastern Europe and the occurrence of our country's two costliest natural disasters. Neither Hurricane Hugo nor the Loma Prieta earthquake were of record size or severity; it is just that they impacted regions in which, over the years, large urban centers have grown up. It is an obvious fact that bears repeating that as population density increases so does vulnerability to large natural disasters.

The central United States was not directly affected by either Hurricane Hugo or the Loma Prieta earthquake. But the indirect effects have been enormous. Interest in, awareness of and concern over the seismic hazard of this region have never been higher.

I will focus my remarks today on the New Madrid seismic zone because any discussion of seismic hazard and risk in the central United States must come to grips with this complex fault system. It completely dominates any estimate of seismic hazard for the central United States.

In my written statement, I go into some detail on the excellent 15-year record of New Madrid research in order to drive home an essential point. Tremendous progress has been made in understanding the New Madrid zone and the hazard it poses. This record of achievement invalidates the argument often heard that we do not understand the seismic hazard well enough to take action, such as seismic protection measures in building codes. It is the same tired argument that is used against action on other such long-term problems as acid rain, ozone depletion, global warming.

I do not want to give the impression, however, that we solved New Madrid, because we have not. Even with major advances in our understanding, we still lag far behind—perhaps decades behind—the relatively well understood plate boundary fault systems of California. And the reasons for this are two-fold: First, the problems posed by the New Madrid zone are more subtle and the processes leading to earthquake generation there are more difficult to detect and measure. Secondly, the federal resources allocated to the study of seismic hazard east of the Rockies are but a small fraction of the resources dedicated to such studies in the west.

An important step has recently been taken to remedy this situation. As a direct result of a letter from you, Mr. Chairman, from

Senator Ford and co-signed by four other Senators, east and west, over 50 of the top scientists and professionals in the nation convened here at Memphis State last month and put together a comprehensive plan that will be submitted to the Congress early next year.

The plan calls for a program of intensified New Madrid research and preparedness activities. I will highlight just a few of its recommended elements. One element is to stabilize support and instrument upgrade of the regional seismic networks. These are the basic tools for seismology and earthquake hazard assessment. As it now stands, two of the three networks that monitor the New Madrid region will lose all federal support in 1992.

Second, installation of more strong ground motion instrument arrays. Again, as things stand now, should a rare, large New Madrid quake occur, priceless and irreplaceable data would not be recorded. Memphis alone should have dozens of these instruments. It has a total of two.

Third, we should exploit new satellite technology to directly monitor crustal strain accumulation in the New Madrid zone. This may be the best approach to true earthquake prediction in mid-continental areas.

And fourth, public awareness and preparedness activities of locally based organizations such as our earthquake center at Memphis State, CUSEC, and St. Louis University need to be greatly expanded. I know at CERI, the MSU Center, we literally cannot keep up with the demand from the public for talks and information.

A major initiative such as the New Madrid plan being prepared for Congress naturally raises the question what is the price tag. From projections generated at the Memphis USGS Workshop, the central U.S. initiative will require funding at a level of five to ten million dollars a year. Ideally the New Madrid seismic network component would be combined with the proposed U.S. national seismic system which is a plan for a national network that would revolutionalize seismological research and hazard estimation in the country. A detailed examination of the cost of the national seismic system has been made by the Panel on Regional Networks of the National Academy of Sciences of which I am Chairman. Its full implementation and operation will cost seven million per year plus a one-time upgrade and modernization cost of $15 million spread over a five-year period.

Thus in summary, the effort required to make a significant difference in earthquake hazard reduction for the nation in general and the central U.S. in particular, will cost $15–$25 million per year. These costs are exclusive of other possible enhancements to the National Earthquake Hazards Reduction Program or of structural engineering research needs. But if they are supported, we will be able to aggressively implement many of the objectives of Senate Bill 1062, sponsored by you, Mr. Chairman, and its companion bill in the House.

If you would, compare this requested level of support with requirements in other disciplines; $5–$7 billion for the superconducting super collider, $3–$5 billion for the human genome project, tens of billions for the space station. Compared to these, the New

Madrid plan and the national seismic system carry a most cost-effective price tag.

Is such an intensified effort at such a cost warranted in the central U.S.? This question leads to the difficult research topic of estimating earthquake probabilities. I will conclude with a few remarks on this subject and I have provided more complete discussion in my written statement.

The well-researched and well-understood San Andreas fault system, the segment that produced the Loma Prieta earthquake, had been assigned probabilities ranging from 30 to over 60 percent of failing in a magnitude 7 earthquake in the next several decades. This is a good example of a successful long-term forecast. Short-term prediction is not possible, even for the San Andreas, the best understood and best instrumented fault system in the world.

Currently there are two long-range probabilistic forecasts for a low magnitude 6 event in the New Madrid zone. One is from a colleague and I where in 1985 we estimated a 40 to 63 percent chance within 15 years, escalating to 86 to 97 percent change in the next half century. A U.S. Geological Survey scientist recently estimated a 30 to 35 percent chance within 30 years. The differences arise because each of us assumes a different model for the New Madrid earthquake generation process.

Given our current incomplete understanding of the New Madrid zone, no one can say which model is "correct" or even which is best. However, for earthquake hazard preparedness and mitigation, this debate is essentially irrelevant. Either analysis yields probabilities for a magnitude 6 event, a dangerous earthquake, that equal or exceed those derived for the Loma Prieta earthquake. Put differently, there is a consensus that a significant hazard exists and it is clearly defined to the point that concerted action at the local, state and federal level is called for. The intensified research program I have outlined briefly today will greatly improve definition of the hazard so that probabilities of occurrence can be specified with much greater confidence and precision. The 1990s, the decade of natural hazard reduction, can and should be the time frame for accomplishing these goals.

Thank you.

[The statement follows:]

Statement of Dr. Arch C. Johnston, Director
Center for Earthquake Research and Information (CERI)
Professor, Geological Sciences
Memphis State University

Mr. Chairman, members of the Subcommittee, thank you for the opportunity to participate in today's hearings on preparing for natural disasters in the United States and particularly the central United States. As a university seismologist, director of an earthquake research center, chairman of the Panel on Regional Seismic Networks for the National Academy of Sciences, and member of the National Earthquake Prediction Evaluation Council for the U. S. Geological Survey, I will of course focus my remarks on the earthquake hazard component of the overall national disaster problem.

The year 1989 will have special significance in this nation's history for at least two reasons: the sudden restructuring of Eastern Europe and the occurrence of our country's two costliest natural disasters. Neither Hurricane Hugo nor the Loma Prieta earthquake were of record size or severity; it's just that they impacted regions in which, over the years, large urban centers have grown up. It's an obvious fact that bears repeating that as population density increases so does vulnerability to natural disasters.

The central United States was not directly affected by either Hurricane Hugo or the Loma Prieta earthquake. But the indirect effects, particularly from the earthquake, have been enormous. Interest in, awareness of, and concern over the seismic hazard of this region have never been higher. Consequently, we now have an opportunity to advance our research efforts into the causes and consequences of mid-continent earthquakes and to improve significantly the efforts to reduce our vulnerability. Such efforts must be made: to not learn and not take to heart the maximum information possible from the California earthquake disaster would be at best short-sighted; at worst, irresponsible.

These hearings today are a very positive step in the right direction. Combined with the U. S. Geological Survey workshop held in this building last month to devise a five-year plan of intensified basic and applied research on the New Madrid seismic zone and the recent U.S. House of Representatives Subcommittee on Science, Research, and Technology hearings on the earthquake threat to the central U. S., planning is well advanced for a concerted attack on fundamental seismic hazard issues in our region. It is now incumbent on the engineers, scientists, politicians, administrators, emergency response professionals, and the public to see that our current knowledge and future plans result in concrete action.

THE NEW MADRID SEISMIC ZONE

Any discussion of seismic hazard and seismic risk in the central United States must come to grips with the New Madrid seismic zone--it completely dominates any estimate of seismic hazard for the region. I've been asked to address the question of the potential for a major earthquake in the New Madrid zone and to suggest effective research avenues to improve earthquake response and preparedness measures. I'll begin by describing the key steps to our current, admittedly incomplete, understanding of this major mid-continent seismic zone.

(1) In 1973 Dr. Otto Nuttli of Saint Louis University published his seminal paper on the New Madrid earthquakes of 1811-1812 (Bulletin of the Seismological Society of America, Vol. 63, pages 227-248) in which he demonstrated for the first time that these were truly great earthquakes, capable of inflicting great damage out to large distances.

(2) In 1974 the first regional seismograph network was installed in the New Madrid zone by Saint Louis University with funding from the USGS. It quickly became apparent the zone was quite active, and the precise locations of the numerous small earthquakes allowed for the first time a confident estimate of the location and extent of the principal fault segments, buried beneath the thick blanket of Mississippi River sediments. These fault segments--defined by the dense concentration of earthquake epicenters--are shown in Figure 1: their identification constitutes a major contribution of regional seismic networks to the specification of seismic hazard.

(3) In 1978 the State of Tennessee Legislature established the Center for Earthquake Research and Information (CERI) at Memphis State University. Since its inception the center has focused its research efforts on the New Madrid zone, and in 1979 installed a second seismic network with Nuclear Regulatory Commission sponsorship to monitor the southern portion of the zone and the Memphis area. In the ensuing decade CERI grew to become the most active organization studying New Madrid, with five major federally-sponsored research projects currently underway.

(4) 1979-1982. During this period the USGS and the Nuclear Regulatory Commission, and groups supported by them, completed a series of studies that for the first time identified and defined the type of geologic structure in which the New Madrid seismic zone lay and the disrupted rock strata of the main active fault segments at depth in the crust.

(5) In 1983-84 the Federal Emergency Management Agency (FEMA) established CUSEC, the Central U. S. Earthquake Consortium, to coordinate and promote emergency response and hazard mitigation activity among the seven member states. This was an important step if only for giving an "official" recognition to the New Madrid hazard.

(6) In 1985 a colleague and I published the first conditional probability estimates for the reoccurrence of major (magnitude 6 or greater) New Madrid earthquakes [Johnston and Nava, "Recurrence Rates and Probability Estimates for the New Madrid Seismic Zone", Journal of Geophysical Research, vol. 90, pages 6737-6753, 1985]. In the time frame

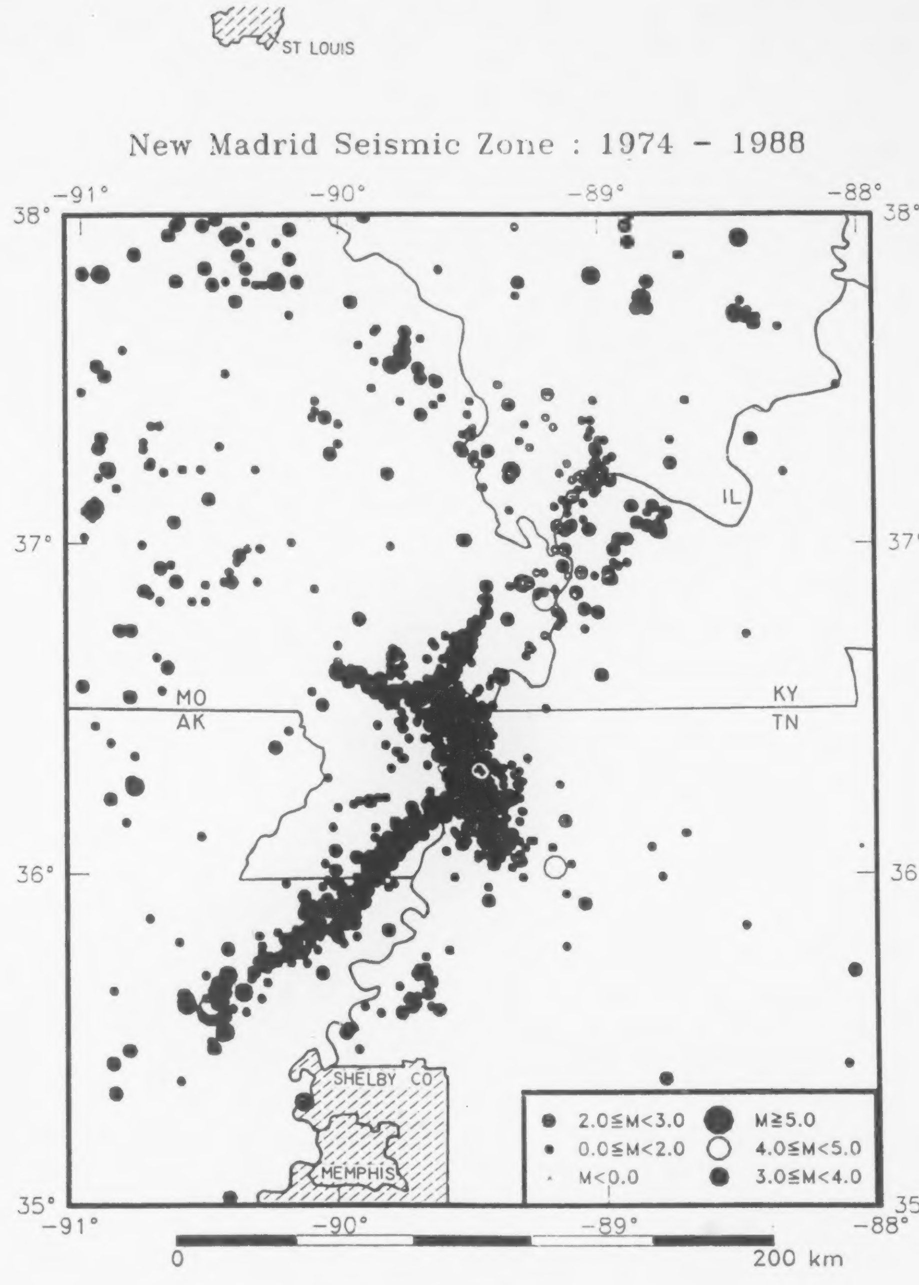
ST LOUIS
New Madrid Seismic Zone : 1974 - 1988
-91°
-90°
-89°
-88°
38°
37°
36°
35°
MO
AK
KY
TN
IL
SHELBY CO
MEMPHIS
● 2.0≦M<3.0
● 0.0≦M<2.0
· M<0.0
● M≧5.0
○ 4.0≦M<5.0
● 3.0≦M<4.0
0
200 km

Figure 1

15 to 50 years, we estimated a very low probability for a reoccurrence of an 1811-type New Madrid event but significantly high probabilities for a low magnitude 6 event.

(7) In 1989 (last month) over 50 of the top scientists and professionals in the country convened at Memphis State University to plan a five-year program of intensified research and research application for the New Madrid zone and regions affected by its hazard.

(8) 1992 (scheduled). Two of the three regional seismic networks that monitor the New Madrid seismic zone region will cease to operate due to withdrawal of Nuclear Regulatory Commission support.

I have gone into some detail on this 15-year development of New Madrid studies to drive home a point: tremendous strides have been made in understanding the seismic zone and the hazard it poses. Public awareness through the continual efforts of CERI, CUSEC and other groups is at an all-time high. Top scientific and engineering talent is in place and eager to greatly expand research efforts. A comprehensive plan for the effort will be published and submitted to Congress early in 1990. And all this has occurred at the advent of an international initiative to significantly reduce vulnerability to natural disasters worldwide over the next decade. Surely there is no more opportune time than now to implement an intensive New Madrid research and applications program.

The current level of understanding of the New Madrid seismic hazard is certainly more than adequate to initiate action. The advances of the past 15 years have invalidated the argument that we don't understand the hazard well enough to take mitigative action, i.e., seismic protection measures in local building codes. This is the same tired argument that is used against other such long-term problems as acid rain, ozone depletion, and global warming.

A NEW MADRID RESEARCH AGENDA

Even with the major advances over the past 15 years in our knowledge of the New Madrid seism. zone, our understanding lags far behind--perhaps decades behind--the relatively well understood plate boundary fault systems of California. The reasons for this are two-fold: the problems posed by the New Madrid zone are more subtle and require a more detailed knowledge of earth processes than is true for the San Andreas system; and the federal resources allocated to study of seismic hazard east of the Rockies are but a small fraction of the resources dedicated to such studies in the West.

There are a number of research and applications actions that can and should be taken in the next few years. They include:

(1) Installation of strong ground motion instrument arrays. Should a large New Madrid earthquake occur tomorrow, priceless and irreplaceable data would not be recorded. For example, there are only two strong motion instruments in Memphis; there should be 30 or more. These data are the best means to quantify soil conditions for seismic wave response, a factor that was so critical in the San Francisco Bay area.

(2) Upgrade of existing regional seismic networks. The existing networks of St. Louis and Memphis State Universities need major renovation and upgrade for incorporation with the new U.S. National Seismic Network. The USGS needs a line budget item to provide long-term, stable support for these nets, especially in the face of the withdrawal of Nuclear Regulatory support in 1992.

(3) A comprehensive program to investigate and assess neotectonic and paleoseismic evidence of pre-1811 New Madrid earthquakes. Such data would comprise the single most important constraint on estimates of the current New Madrid earthquake potential.

(4) Exploit new satellite technology to directly monitor strain accumulation in the New Madrid zone. This is probably the most promising approach to true earthquake prediction in mid-continent seismic zones. The Global Positioning System (GPS) program makes such a project feasible and cost-effective.

(5) Greatly expand the support for the public awareness and information activities of locally-based organizations such as CUSEC, CERI, and St. Louis University. CUSEC should be staffed with some preparedness, mitigation, and response professionals.

Major initiatives such as points (1) through (5) above raise the question: What is the price tag? In-depth examinations of this question have already been conducted. The seismic instrumentation portion will cost $12 million per year nationwide, or $5 million per year above current appropriations, and a one-time upgrade and modernization cost of $15 million, spread over a five-year period, is estimated. A detailed examination of these cost may be found in the report of the National Academy of Sciences Panel on Regional Networks, "Assessing the Nation's Earthquakes: The Health and Status of Regional Seismic Networks" [NAS, 1990].

The other components of the intensified research and applications plan will cost from $5 million to $10 million per year. The explanation for these costs are contained in the proceedings of the recent Memphis USGS workshop and will be published as a USGS circular in early 1990. In summary, then, the effort required to make a significant difference in earthquake hazard reduction for the nation in general and the central U.S. in particular will require additional funding at the level of $15-25 million per year. These costs are exclusive of other changes to the NEHRP or of structural engineering research needs. Compared to the billions required by projects in other disciplines--$5-7 billion for the superconducting super collider, $3-4 billion for the Human Genome Project, and tens of billions for the space station--this is a most cost-effective price tag.

WHAT IS THE POTENTIAL FOR A LARGE NEW MADRID EARTHQUAKE?

Given that earthquake prediction is not presently feasible--especially in mid-continent areas--what can be said concerning this basic question? I would like to answer this question by first reviewing the published forcasts for the October 17, 1989 Loma Prieta earthquake.

A high potential for a major (magnitude approximately 7) earthquake on the Santa Cruz Mountains segment of the San Andreas fualt had been forcast by at least three independent research groups. In 1984 Sykes and Nishenko had assigned a 60% probability that this fault segment would rupture in the time frame 1983-2003. Subsequently, two USGS geophysicists and a working group of the National Earthquake Prediction Evaluation Council reduced this estimate but still gave it about a 30% chance of rupture in the next 30 years, the highest potential of any fault segment in northern California (a Hayward fault segment was also ranked this high). Independently, Dr. Christopher Scholz of Columbia University, considering a somewhat longer fault segment than actually ruptured on 17 October, estimated about a 50% likelihood of rupture in 30 years.

I quote these California probabilities to illustrate three important points concerning earthquake forcasting. First, a probabilistic "forcast" is not a "prediction" in which a time, place and magnitude are specified within narrow limits. A prediction could be considered a very short-term forcast. Second, the occurrence of the Loma Prieta earthquake within the forcasted time, space, and magnitude ranges has done much to validate the methodology employed for such long-term forcasting. This analysis approach uses a time-dependent model of the earthquake generation process, in which the probability of occurrence of a given size earthquake on a particular fault or within a particular seismic zone is dependent upon the time that has elapsed since the last occurrence of such an event. And third, even for a segment of the San Andreas, the best studied and best understood fault system in the world, independent expert analyses led to widely different (a factor of 2 or 100%) estimates of the conditional probabilities.

For the New Madrid seismic zone, short-term forecasts or predictions are not possible given our current level of understanding. I, along with colleague S. Nava, have made long-term probabilistic estimates for major New Madrid earthquakes [the previously-cited 1985 paper in the Journal of Geophysical Research]. At the recent USGS workshop, estimates were given by a USGS scientist that were considerably lower than our published estimates for the probability of occurrence of a low magnitude 6 New Madrid event. I would like to end this written statement with a comparison of these two forecasts.

Nava and I estimated that a low magnitude 6 earthquake had a 40-63% probability of occurring somewhere on the principal fault segments of the New Madrid seismic zone (Figure 1) within the next 15 years and a 86-97% probability within the next 50 years. In our analysis we employed the same time-dependent model of earthquake occurrence as was described above for the Loma Prieta earthquake. We reasoned that even though New Madrid is not a plate boundary fault system and even though its earthquake generation process is not nearly so well understood as the San Andreas, the same mechanism of gradual accumulation of stress followed by sudden failure must govern New Madrid earthquakes as holds true for the San Andreas and other fault zones worldwide. This means our estimated probabilities will gradually increase with time since the last magnitude 6 New Madrid event in 1895. Because analysis of earthquake catalog data indicates magnitude 6 events should repeat roughly every 70-90 years (with large uncertainty), the elapsed time of 95 years leads to high probabilities under the time-dependent formulation.

S. Nishenko of the USGS utilized a time-independent or "random" model of the earthquake process to derive an estimate of 30-35% probability of a low magnitude 6 New Madrid event in the next 30 years. Even though the exposure time interval is different, his estimates are roughly one-half of those published by Nava and myself. His implicit assumption was that we simply do not know enough about the earthquake generation process in the New Madrid zone to justify use of a time-dependent earthquake model. Our position is that studies have advanced to the point that a time-dependent model is justified: earthquake occurrence in the zone should not be random, but should depend on the elapsed time since the last large strain-releasing event. To be conservative we attached large uncertainties to the model parameters; hence the wide range of our quoted probabilities.

The discussion of the above paragraph is summarized in Figure 2 in which time-dependent and time-independent probability estimates are shown for the 200-year time interval since the magnitude 6.2 Charleston, Missouri, earthquake in 1895. Note that shortly after that event the constant probability of the random model is much higher than the time-dependent estimates, but that after about 40-50 years elapsed time, the time-dependent estimates become the greater and the margin continues to increase as more and more time goes by.

Given our current incomplete understanding of the earthquake generation mechanism of the New Madrid seismic zone, no one can say with certainly whether it should be modeled as a time-independent or time-dependent process. However, for earthquake hazard preparedness and mitigation purposes, this is really an inconsequential point. Either analysis yields probability estimates for a New Madrid magnitude 6 event that equal or exceed those derived for a magnitude 7 event on the Loma Prieta fault

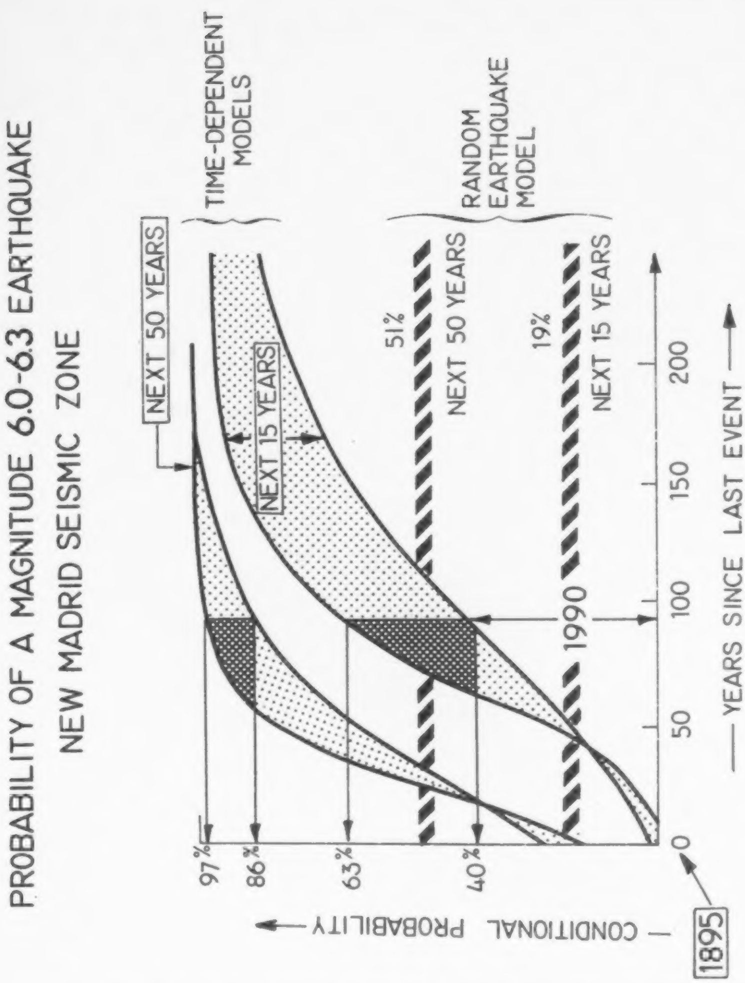

Figure 2

segment. The hazard is clearly defined to the point that concerted action at the local, state and federal level is called for. And the intensified research program briefly outlined in this testimony should be able to give us a much improved definition of the hazard so that probabilities of occurrence can be specified with much greater confidence and precision. The 1990s--the Decade of Natural Disaster Reduction--can and should be the time frame for accomplishing these goals.

Senator **Gore**. Thank you very much. We appreciate that and we will hold questions until Mr. Suiter has finished his statement. Lacy Suiter is Director of TEMA. I have said on many occasions how fortunate I feel we are in our state to have you running this operation, Lacy Suiter, and at the national level we have benefited from your participation in many federal programs related to this field, and really do appreciate you helping us out here today.

Please proceed.

STATEMENT OF LACY E. SUITER, DIRECTOR, TENNESSEE EMERGENCY MANAGEMENT AGENCY

Mr. **Suiter**. Thank you, Senator. I appreciate the opportunity to be here—Senator Ford, thank you, sir.

It is a pleasure to appear before this subcommittee today to address what steps we might need to take to reduce the earthquake hazard here in the central United States. Before I get into a couple of comments, I would like to remind both the Senators that the annual meeting for the Central United States Earthquake Consortium is going on here in Memphis right now. In the room are the state directors of emergency preparedness or emergency management from the seven member states. Judge Whitt from Arkansas is here; Jerry Hauer from Indiana; Mike Malloy, General Malloy, from Kentucky; Jim Marhar from Mississippi—what states have I missed here—Illinois, Tom Ortsinger, I do not know whether he is here or not—and Missouri, R.D. Ross, and obviously myself.

In addition to that there are a number of local emergency management directors in Tennessee who bear the real brunt for preparedness for earthquakes or anything else that happens in terms of emergency management in the state. We think we have some of the better local directors in the country. As a matter of fact, I came back from California, when I went out to observe Bill's operation and what had happened during the earthquake, pretty upbeat. I came back here looking at what we had been doing in the last several years in terms—especially in the more rural counties; looking at Gibson County and I think Trish and some of the rest of them are in the room right now, they have had basic emergency operations plans ready for response to an earthquake within the limits of their resources for several years now. There has been a rather extensive public awareness program in schools in the counties north of here who are most at risk, for some time. And Memphis-Shelby County, I agree with Mayor Hackett that Memphis and Shelby County is very fortunate to have Jeff Crenshaw and his staff. As a matter of fact, they even stole one of our people, Charlie Bryant, to go over to their staff and work.

So we think things are going along quite well in the—or at least we are progressing.

This state has a powerful executive order signed by Governor McWhorter, Executive Order 4, it directs that all the resources of Tennessee state government in the event of an emergency preparing for, responding to or recovering from will be concentrated and coordinated, directed if necessary through the Tennessee Emergency Management Agency, a single voice. If something goes wrong, there is no doubt in anybody's mind who messed up or what happened or who did it well.

We are not particularly interested in who gets the credit for these things, what we are particularly interested in doing—as a matter of fact we could not care less who gets the credit, the only thing we care about is success in it. What we are particularly interested in doing is making sure that we have the resources and the activities to get these things done. All the resources have not always been there, but the resources that we have had, if you consider how little money has been appropriated to these functions in the past, we think the resources that we have had have been used pretty wisely. As a matter of fact, indeed if we had the millions of dollars that have been appropriated for other functions, there is no telling how much good we would have done in a number of areas. So we think we are going along that way.

I also want to make sure that we recognize that Robert Frost is in the room. Robert is the Commissioner—I am sorry, the Assistant Commissioner for the Department of Commerce and Insurance and in charge of the codes issue that we have in this state. Bob and I have been working together.

I also wanted to remind everybody in the room that emergency management is a little bit more than earthquake preparedness. My agency alone is responsible for Title III, the Superfund. We have about 3000 hazardous material accidents in this state on our highways every year. We manage those responses along with the local governments. Severe weather, floods, tornadoes, wind, flash flooding, those types of things that happen. There are three nuclear power plants; Sequoyah, Watts Bar, Browns Ferry, all of which the emergency services off-site, out to 50 miles around those areas are our responsibility. We have the Department of Energy entering into a major exercise at Oak Ridge March 22 testing indeed whether or not the state and local government—what their capabilities are to manage a major emergency from there. Our attack preparedness issues, landslides, forest fires, transuranic waste shipments across the state, all the other emergencies that occur, including the response and the recovery therefrom once the President declares, and in this state since we have limited authority in terms of state declared disasters for taking care of some of our own—and beyond that we have to balance getting all these things done with auditors and IGs who are constantly coming around, "are you spending the money in accordance with the way it was appropriated by the Congress or the Tennessee General Assembly", so it is a big mission, it is a fun mission, the very best job in Tennessee state government to have, and I can tell you when I go to work every day there are two things; I am very grateful for the people I get to work with and I am very grateful to be in this job because it is a fun job.

There have been a couple of things that have been said in the past, and I am not going to read through this whole statement here—but there have been a couple of things that have been said and I know that Dennis, when he made the statement here about D plus or C in preparedness, he was not talking about preparedness in the sense that we talk about it. And I would like to take just a moment, if I could, sir, to explain what that definition is, and

I think it is important to define the difference between preparedness and mitigation.

As we deal with it, preparedness includes a range of actions that emergency management officials and others need to take to prepare all levels of government as well as the general public for an earthquake. Mitigation is a long-term process that addresses measures that need to be taken to reduce the impact of the hazard, such as in the case of earthquakes. The terms preparedness and mitigation are intermingled, but in reality each involves different strategies.

Mitigation is inherently political, involves policy decisions and these decisions may not lead to results for several years in terms of replacing the built structures, the built society, in terms of retrofitting or whatever we might be talking about in some of these buildings.

Preparedness, however, involves response planning, knowing in the case of medical emergencies where the helicopters are going to be if the bridges are down and how to get them in here and get people out and where they are going to, knowing how to get the medical technicians in. And to that end, this state and four of the other states in the central United States have all passed disaster compacts. Two more states have to act on it, Kentucky and I believe Indiana have to act on that, and when we do, we will be coming to the Congress then asking for an endorsement of that pact and to let us waive certain things that have to go across.

From this perspective, and I will focus my comments on the action that can be taken in both preparedness and mitigation to move the earthquake program ahead, considerable progress has been made in the area of earthquake preparedness in Tennessee under the National Earthquake Hazard Reduction Program. Awareness and education programs have raised the visibility of earthquake risk throughout the region, even if it has not raised it to the level that we would like to see it.

School programs have been more effective than perhaps we have realized and certainly in the more rural areas of the state. Big Bird, which you would have launched April 7 in Washington, Tom and myself and some others were there, has helped to imprint earthquake preparedness in the minds of thousands of school children. In the basement of CUSEC, the facility you dedicated April 3 over here, you will find Tennessee Department of Corrections inmates in there every day assembling I think upwards of 50,000 of those kits, Big Bird kits, to pass around to the school children in this region and they are in a line. We will be doing the same thing in the Nashville area very soon. So a lot of activities in those areas have been taking place.

Response plans are in place for the most part and they are being exercised. December 1 we called the staffs of the different agencies together under the authority of Executive Order 4, Tennessee State Government Executive Order 4, with a no-notice exercise. They thought they were walking in the door to sit there and to go through a normal routine emergency services coordinator briefing. When they walked in, we had been exercising since 5:30 in the morning. Quite frankly, sir, it was a smashing success in terms that the agencies have not been sitting around on their duffs doing nothing, they have been thinking about this problem and working on it in terms of response planning, in terms of preparedness and in terms of what might be laying for them in terms of earthquakes. That is the second earthquake exercise we have had this year, one before the Loma Prieta earthquake and then this one, over 200 state personnel.

What they do not know and I see some of them in the room and I am giving it away right now, when they come to the next emergency services coordinator meeting on April 12, that exercise picks up where the last exercise left off, so we will get more into the recovery effort and talking about some of the things that Bill was talking about in search and rescue.

California's response to the recent earthquake demonstrated the value of exercising and local preparedness. We think we were doing a lot of these things in this state and I am sure in my sister state, except maybe not exercising as much as we should. But we have tried it. We have bee using a lot of technology to get to that point from the standpoint that we conducted one of the exercises in the middle of Reelfoot Lake and televised it, the same folks that will be seeing the television program this afternoon, around to all the rest of the state and actually had downlink receiver sites in the auditoriums or in the emergency operations centers of the local government.

CUSEC has been instrumental in raising the level of preparedness in the central United States and I am pleased to acknowledge the contributions and the support that Governor McWhorter has given to CUSEC in terms of providing the building, in terms of providing the financial wherewithal to operate the structure itself, the utilities and things like that, as well as to Shelby County who has provided cash support to keep it going. We think we are supporting that program and want to certainly endorse the effort by the two mayors to make sure that Memphis is an earthquake research and preparedness center.

With that I will conclude my comments and try to answer any questions.

[The statement follows:]

Testimony of Lacy E. Suiter, Director
Tennessee Emergency Management Agency
Before the
Senate Subcommittee of Science, Technology, and Space
December 11, 1989

Mr. Chairman and Members of the Subcommittee: It is a pleasure for me to appear before the Subcommittee on Science, Technology, and Space to discuss the effects of an earthquake in the central U.S. and how State and local government in Tennessee would respond; the measures that can be taken to decrease the earthquake hazard in Tennessee; and most importantly, the identification of barriers to implementing a realistic, integrated, workable earthquake preparedness program, with recommendations for overcoming these barriers.

As director of the Tennessee Emergency Management Agency, I take pleasure in testifying today for a number of reasons. First, my involvement in earthquake preparedness efforts in the central US. can be traced back to 1981, when the seismic risk first came to the attention of the emergency management community, primarily through the work of the late Dr. Otto Nuttli. I have a personal and professional investment in the earthquake program both in Tennessee and the central U.S. Secondly, there has been considerable speculation and debate in recent months on the level of preparedness on this side of the Rocky Mountains for an earthquake. One earthquake authority recently rated the level of preparedness in the central U.S. at 10 on a scale of 1 to 100, with San Francisco scoring a 90 and Armenia 0. Such numerical ratings are overly simplistic; highly debatable if not inflammatory; and tend to obscure the real issues of preparedness: how to change attitudes in the cental U.S. towards earthquake preparedness and mitigation; and ultimately how to change behavior, particularly among decision-makers in the public and private sectors.

With this personal observation aside, I would like to turn my attention to the first two questions that were posed: "What would be the effects of a major earthquake on the New Madrid Fault and how would state and local authorities respond?" We are under no illusion that a major earthquake in the New Madrid zone would have a devastating impact, depending on the time of day, the location of the epicenter and the duration of the earthquake. Memphis is one of six cities that was examined in a 1985 FEMA funded vulnerability study. The "Six City Study" postulated a 7.6 and 8.6 earthquake, and examined the impact of earthquakes of these magnitudes on the central U.S. and specifically twelve categories of "critical facilities" (schools, hospitals, utilities, roads, etc.). The findings of this study have become part of the lexicon of earthquake planners and other officials: $30 billion in damages, up to 10,000 casualties in Memphis (one fourth of whom could be school children), up to 230,000 temporarily displaced, utilities and lifelines destroyed, and a devastated economy that would take months if not years to. In a word, the findings were overwhelming. The consolation is that an earthquake of magnitude 7.5 or greater only has a 10 percent chance of occurring in the next twenty years. Of more concern to emergency preparedness officials are the more moderate earthquakes - in the magnitude 6.0 to 6.8 range - that have a much higher probability of occurring. In fact, there is a need for a loss estimate study that examines the impact of a more moderate sized earthquake (6.0 to 6.8) on Memphis and other population centers in the central U.S.

While acknowledging that a moderate or major earthquake in Tennessee would cause unprecedented casualties, damages and economic losses, it should also be recognized that Tennessee has a State and local emergency management system in place that is supported by 50,000 volunteer and paid professionals across the state. The dedication and commitment of State and local emergency responders is an invaluable resource in any emergency. In fact, a seven day invitational trip to California following the earthquake only served to reinforce my conviction that, at least in the emergency response arena, Tennessee is on an equal footing with California. This can be attributed, in large part, to the strong tradition of support from the executive and legislative branches of Tennessee State government (Tennessee has the largest State Emergency Operations Center in the nation and one of the largest, best trained staffs).

One inescapable lesson that emerged from the California trip is that there is no substitute for constant exercising of emergency operations plans. On several occasions, California emergency personnel remarked on the ease of the transition from performing in exercises to performing in the actual event.

Tennessee recently concluded a statewide earthquake exercise of the West Tennessee Emergency Operations Plan. Approximately 200 State agency personnel gathered for the one day exercise of the most important emergency response functions that need to be carried out if an earthquake were to suddenly occur. The exercise went extremely well in that problems were identified and dissected; training requirements were spelled out; and most importantly, State agency personnel left the exercise with a renewed commitment to earthquake preparedness.

Perhaps the most critical factor in response to an earthquake is time. Examination of recent earthquakes reveals that approximately 75 percent of all lives that are saved after an earthquake occur in the first 24 hours. In short, it is vital that State and local training focus on the "first responders", including the "spontaneous volunteers" that arrive on the disaster scene to begin the search and rescue operations.

In view of the importance of the time factor in earthquake response, TEMA is working closely with West Tennessee officials to identify specific responsibilities and functions that must be carried out in the first 72 hours following an earthquake. Terminology has been standardized. Staging areas have been identified and the State is in the process of training "overhead teams" which can be deployed to the disaster site within hours. Through the use of the Incident Command System (ICS), Tennessee has also developed a hierarchy of "command posts", from the State Emergency Operations Center in Nashville to the scores of incident sites in the impacted areas. Through the ICS, each command post will have a team of disaster specialists who perform prescribed functions (incident commander, operations, logistics, disaster intelligence, media relations). Again, the concept of operations calls for predesignated teams of trained specialists to establish command posts and carry out prescribed emergency functions.

Within this organizational framework, State assistance to Memphis or any other Tennessee jurisdiction would include the following: disaster intelligence (determining the magnitude and scope of damages); emergency medical assistance (including medical evacuation); road and bridge inspection, debris clearance to facilitate access to the damaged areas; emergency shelter; communications support and other emergency services functions that may be requested by local authorities. In essence, the State of Tennessee, through TEMA, is accelerating the earthquake response and recovery program to maximize efficiency in the movement of resources to Memphis or other jurisdiction in the event of an earthquake.

A fundamental problem that has surfaced in every response to an earthquake, including the Lomo Prieta earthquake is disaster intelligence, or the process of gathering disaster information and transmitting that information to decision makers. The disaster intelligence function was one of the major problem areas that was exposed in the recent Tennessee exercise.

The integration of information technology and emergency response plans and procedures is critical, as you are well aware, Mr. Chairman. The emergency management community wants to acknowledge the leadership role that you have provided in the interface between technology and local response. However, I agree with your observation on the day following the Lomo Prieta earthquake: we are still not making necessary progress in applying the technology to the practical problems at the local level. The image remains in my mind of a frustrated Ted Koppel, sitting in one of the most sophisticated studios in the world three hours after the earthquake, with no clear idea of the disaster scenario in Santa Cruz and other damaged sites. Problems such as these would be compounded in the central U.S. by virtue of the regional impact of an earthquake in this part of the country. In essence, the technology to solve these problems is available; the underlying problem, and challenge, is to raise priorities, to obtain commitments of time and necessary resources to solving the problems, and in following through with post-disaster evaluation of the application of technology to emergency response.

For the remainder of my testimony, I would like to address some of the key issues that are, I think, at the heart of this timely hearing: "What are the barriers to improving the level of earthquake preparedness (and disasters in general)?" "What measures need to be taken to overcome these barriers?", and "How can we improve the level of mitigation and preparedness for earthquakes and other disasters in Tennessee and other states?"

Mr. Chairman, I have given considerable thought to the issue of barriers to implementing earthquake preparedness measures in Tennessee and the central U.S. While the Central U.S. Earthquake Consortium (CUSEC) and member states have made important strides in raising public awareness of the earthquake problem, this awareness has not been translated into meaningful action. While we have the knowledge base and technology to strengthen our buildings and infrastructure, we continue to construct a new generation of structures and facilities that will generate casualties in the damaging earthquake that is predicted to occur. While we have the technology to dramatically enhance emergency communications, urban search and rescue and other response functions, we continue to be plagued by recurring problems in actual events that could be resolved by utilization of this technology.

I think it is time to acknowledge the shortcomings of our approach to disaster preparedness and to devise a new strategy that takes into account, and fully accommodates, the realities of the "political" world (I use the term loosely, to include key private sector decision makers). In short, I think that we need to focus our attention on what it is going to take to instill a "mitigation ethic" in our society. Mitigation needs to be incorporated into the curricula of schools of public administration, planning, architecture, natural resources and engineering. Business leaders, particularly the finance and insurance industry, need to factor mitigation measures into their decision criteria for loans and insurance policies. The "mitigation ethic" could be an important tool in reducing the federal deficit.

Federal funds to support disaster relief could be substantially reduced through a renewed emphasis on hazard mitigation.

Perhaps the greatest opportunity for enacting mitigation measures is in our own backyards. I am suggesting that we re-examine our approach to promoting mitigation at the local level. Let's acknowledge on the front end that mitigation is intensely political, and perhaps a key barrier to mitigation has been the propensity of mitigation advocates to force feed technical solutions to problems that have enormous political ramifications. Mitigation ultimately involves decisions of trade-offs (more restrictive building codes/safer population in the long term versus higher building costs and attendant political problems). In short,mitigation advocates and local decisions makers should collaborate in pursuing political solutions, and well as technical solutions, to hazard mitigation and preparedness. While attention has focused on the use of information technology to support emergency response, there is an acute need for the application of computer modeling and technology to support decisions involving mitigation trade-offs. In essence, political decision makers need to be able to "break down" the complexities of decisions involving the adoption of mitigation measures; they need to be able to see clearly what the trade-offs are; and they need to understand the full implications of their decisions (adopting, partially adopting or failure to adopt a particular mitigation policy).

Decision making support systems, as described above, could become an integral part of a regional demonstration project for the Memphis region. The primary purpose of such a project would be to focus federal resources on the application of existing technology to meet the complex problems of disaster mitigation and response, with an emphasis on earthquakes and technological hazards. A demonstration project would serve a number of other objectives: provide the impetus for meaningful interaction among the scientific community (CERI), including the preparedness community (TEMA, Memphis EMA, and CUSEC), elected officials and other key groups. Emphasis should be on application of knowledge and research; on projects that lead to action and results; on projects that contribute to overcoming barriers to mitigation and emergency response; and on projects that contribute to constituency building. The business community, for example, is a key constituent group whose support has been under utilized in Tennessee.

In the final analysis, the most effective measure that can be taken to improve earthquake preparedness is to place increased emphasis on every phase of a national program and to make earthquake preparedness a national priority. S. 1062 is a significant start in this direction, particularly the amendments that redirect resources to increase Public Education (Section 8) and Earthquake Planning and Response (Section 9).

In spite of the initiatives embodied in S. 1062, the fact remains that federal funding for the National Earthquake Hazards Reduction Program has eroded substantially since the program's inception in 1977. Practically every barometer that one chooses to use will confirm the fact that we are simply not committing the necessary resources to the problem. In Japan, for example, approximately $2 billion is allocated to their equivalent of the NEHRP, or approximately $16 per capita (compared to $0.27 in the U.S.) The real disparity, and one which is difficult to measure, is in the commitment of the private sectors in the two countries to earthquake preparedness.

In closing Mr. Chairman, I think you will agree that we must instill a national sense of urgency to improving our collective level of preparedness for an earthquake. We must do a better job of adapting existing technology in support of emergency response and recovery. We must do a better job of integrating the private sector - insurance, finance, business and industry - into state and local mitigation and preparedness efforts, including the use of incentive programs. We must instill a sense of urgency among elected officials to adopt seismic provisions in building codes. In this sense, I am encouraged by Section 7 of S. 1062 that calls for the adoption of seismic design and construction standards in new and existing federal buildings and facilities, including those involving federal domestic assistance. In the final analysis, Congress and the Administration need to address the fundamental issue of raising the visibility and priority of the NEHRP through an infusion of federal dollars into the program.

Senator GORE. Thank you very much, Lacy.

Before we go to questions, just to round out this presentation on earthquake preparedness in the Memphis area, I am going to ask the staff to present a five-minute video prepared by the Library of Congress which highlights some of the issues that we want to discuss in the questions.

If they can pull the screen down and if we could turn the lights off just one more time, then we will watch this brief presentation and then go to questions for the panel.

While the screen is coming down, let me say that Bob Chartrand of the Congressional Research Service at the Library of Congress has worked with the Subcommittee and he is responsible for producing this five-minute video.

[Videotape shown.]

An 8.0 New Madrid quake is not likely in the near future but an earthquake one point lower than that on the Richter scale is much more likely. And of course the larger quake could occur, indeed has occurred, and will occur again at some point.

But do we really appreciate how much damage could be associated with a quake of that kind? Just listening to that scenario being played out, it reminded me of factors that would be way down on the list of things that I would think of; blood banks being knocked out for example. But that is what your people do on a regular basis, Lacy—plan for contingencies that the rest of us do not really spend time thinking about. We certainly appreciate the work that you do.

In order to predict the likelihood of a large quake and where the stresses are building up, we need the kind of research that your center does, Dr. Johnston. In California, the geologists were able to forecast were able to forecast this latest earthquake partly because they had a local network. You mentioned the seismic network that Memphis State is operating and how funding for the network is now in jeopardy. How important is the data from this network? The USGS, as we will hear in the next panel, is building a national seismic network, yet I am given to understand that it will not be able to replace local networks like the one which focuses on the New Madrid fault zone. Why do we need both networks?

Dr. JOHNSTON. Both networks linked together would enable us to conduct both the detailed, small-scale studies that are needed—to give you an example, to specify seismic hazard, one important component is knowing the frequency of occurrence of earthquakes and the larger the magnitude range over which you can do that, the much greater you can specify the hazard. Now the national seismic network will have greatly improved instruments, satellite link, real-time capabilities, but it will not detect most local earthquakes below a threshold of maybe 2.5 to 3. Well these smaller earthquakes are much more frequent. That means that 80 to 90 percent of the total number of earthquakes that occur would not be detected and located by the national net. So a partnership is needed between regional networks in the principal seismic zones and the national network.

Senator GORE. What is your best estimate of the odds of a major earthquake in the eastern United States in our lifetime?

Dr. JOHNSTON. Magnitude six or greater?

Senator GORE. Ninety six percent?

Dr. JOHNSTON. No, excuse me. It is very dependent on the magnitude——

Senator GORE. Oh, six or greater, I am sorry. All right.

Dr. JOHNSTON. Well I have not done—studied the whole eastern U.S. It comes down to a question of combining it from individual seismic zones, so I would say a magnitude six or greater we certainly have greater than a 50 percent chance in our lifetime.

Senator GORE. Others have said, who have collated that data, have gone as high as 95 percent, a 95 percent chance of a quake that size or larger in the eastern United States in the next 40 years or so.

You have made it clear, Dr. Johnston, that the National Earthquake Hazard Reduction Program needs adequate funding if it is going to adequately address the threat of earthquakes. In the last ten years we have learned that the threat of earthquakes in the eastern United States is greater than most people have thought; yet, in those same ten years, we have seen funding levels for the earthquake research program decrease 35 percent in real dollars. Why do you think that has been the case?

Dr. JOHNSTON. I think that the basic problem is that earthquake hazards and earthquake mitigation research are long-term and there are very many short-term problems and then we are brought up and confronted with major events such as the Loma Prieta earthquake. So what is needed is a stable, long-term effort. And I think the Senate bill you have introduced goes a long way towards stabilizing and enhancing support for earthquake research and preparedness activities.

Senator GORE. Okay. Mr. Suiter, you introduced your colleagues from state government in the Department of Commerce.

Mr. SUITER. Robert Frost.

Senator GORE. Robert Frost is here. What is the status of the State of Tennessee code effort?

Mr. SUITER. Okay. Robert could probably speak to this better than me, but I do have some notes to work from. It says the Department of Commerce and Insurance intends to adopt the 1988 Standard Building Code in its entirety, including seismic design provisions. This has to go through the rulemaking process which will be completed in April of 1990. There are 26 exempt cities who do have the option to adopt a code less restrictive than the 1985 code. However, we anticipate that all will go along with the 1988 code. Knoxville and Chattanooga have already adopted those codes.

Senator GORE. All right. Now can you give us some idea of how much that will add to construction costs, on average?

Mr. SUITER. I was participating in a program down here last week, there seemed to be a lot of argument. A local engineer by the name of Inman said that it would be in the neighborhood of five to ten percent, another said it would be in the neighborhood of 25 percent. I presume there are people in the room that are more qualified to answer that than I am, but we are told reliably that it is in a range of five to ten percent.

Senator GORE. What can individuals in Memphis and west Tennessee and west Kentucky do to prepare themselves for earthquakes? Is there anything you would advise individuals to do?

Mr. SUITER. Each of our local governments are participating in developing their own local, tailored for their communities, preparedness and training programs. Up in Union City, the Obion County instance, there have been programs adopted telling you what to do in the home and in the workplace. Charlie Roberts, our local director there, has been out working with those areas.

I think that it is important that the officials of the local governments understand that the people that live in these areas, the ones that are most at risk, want—expect that their government will have some type of provisions, either in earthquake codes or training or whatever else. And since we live in one of the most litigious societies in the nation, with all the warning that has been placed before all of us by Arch and the late Dr. Otto Nuttli and the others in there, this is no surprise. I agree with Mayor Morris and Mayor Hackett, we did not all of a sudden wake up on the morning of October 18 and discover we have an earthquake threat. We have known it for a long time. But there are a lot of priorities out there, better schools, better roads, more jobs, things like this. And we are competing in those areas. I think the people have to make themselves known to their local officials, what it is they expect out of their local governments in these areas. And I think they are doing so.

Senator GORE. One final question, in the last panel we heard both from California and Armenia that the types of soils in the high-risk areas had a lot to do with which buildings were vulnerable and which ones were not. Construction techniques, building codes, soil type were all important.

Dr. Johnston, is there anything you can tell us about the variation in soil conditions in this area that ought to be a part of this record? What should we know about that?

Dr. JOHNSTON. In Memphis-Shelby County of course, there is no bedrock available for building. So our soil can range from very bad to actually fairly good. We have a major study funded through the National Center for Earthquake Engineering Research to do a soil factor map for the entire county. It is a difficult area to research.

For instance, we have got well logs from over 8,000 wells in the county, but the soils would definitely be a factor, and a negative factor, in some areas of the city. But much of the city is on the bluffs and with the thick deposit of soil we call loess, these areas would actually perform fairly well.

It affects things like what is the percentage of the cost to design seismic versus non-seismic. If you are on good soil, it can easily be as low as two percent. So these data will be useful not only for disaster scenarios, but also for cost estimates for land use planning, where you will put facilities, particularly critical facilities.

Senator GORE. Very good. Thank you.

Senator Ford.

Senator FORD. Dr. Johnston, I am just sitting here imagining that I was living resident near the New Madrid fault in Kentucky and trying to understand the difference between California faults and those in the eastern United States.

Dr. JOHNSTON. The California fault systems, the San Andreas system, is part of a global grid of faults that are the boundaries of what we call plates of the earth. And these plates are in slow movement relative to each other and the boundaries are locked until broken loose by an earthquake. So we have a good basic understanding of that process and where the forces come from to generate earthquakes on the San Andreas system.

For the New Madrid system, however, we are right in the middle of the North American plate, nowhere near a plate boundary, and so it has been much more difficult to understand why earthquakes are generated there. Another difficulty is that the faults are deeply buried beneath the sediments of the Mississippi River. We cannot study them at the surface, as you can in California. So we have had trouble even delineating the extent of the New Madrid zone. That was one of the major achievements of the past ten years. So those two factors combined, give us a much lower level of understanding of the geology and geophysics of the fault zone itself.

Senator FORD. Well have geologists been able to pinpoint the New Madrid fault? Could we, say, go out there, put a flag up, stand on the fault, and say this is it? We could probably charge admission and students would come in busloads.

Dr. JOHNSTON. Well, we have a—Dr. Buddy Schweig, one of our faculty—has a very promising project first using remote sensing and now actually doing some trenching studies, that we think we have got a very good possibility of locating an actual trace of one of the 1811–12 earthquakes, a fault trace itself, that came up through the sediments.

Senator FORD. Well you are not really sure about it? You have not got it pinpointed yet?

Dr. JOHNSTON. Right. In science, you are guilty until proven innocent. You have to remove all doubt essentially, and so that will be the objective for the next year or two with that project.

Senator FORD. You just mentioned, Mr. Suiter, that the state was getting ready to adopt its new building code. What will be the economic impact on these new provisions?

Mr. SUITER. Senator, I am not trying to duck your question, but that is not in my realm of expertise or authority but I will certainly submit a response to that question for the record.

Senator **Ford**. Well, I listened to Mr. Medigovich's statement, and he said that for 50 years Californians have known about all this and they have been trying to retrofit buildings and strengthen their building code. They started in 1933 and they have improved, and yet 50 years later, they have tens of thousands of buildings and highways and bridges and everything else that has not been retrofitted. They are not yet prepared for what they know will come, and earthquakes are more frequent in California than any other place in the continental United States.

Mr. **Suiter**. It is my understanding that the 1933 Act required seismic provisions in all of their school systems out there and it took them about 50 years to replace all of the schools that had that activity. We have not done that in the central south yet, in our particular areas. It is my understanding that they have a lot of seismic provisions included in all of their road and bridge construction, a lot of that resulted after the 1971 earthquake, San Fernando Valley earthquake, that they had where the interstates collapsed. Interstates in this state are not built with seismic provisions to those levels; however, most of our interstates, bridges, are overbuilt. It does not mean that they are going to survive, we do not know that yet. We hope that the good work that the USGS and our friend here, Arch, is going to do is going to tell us specifically what we can expect in a 6.0 up to a 7.0, that area they say is most likely to happen, so we can begin planning more specifically for that type activity, and we anxiously await those results.

Senator **Ford**. I do not know which one would want to answer this, but what if we doubled the budget. How would that affect your work, Dr. Johnston, and yours, Mr. Suiter, if we doubled the federal earthquake program budget. That is not going to be a whole lot of money and yet if you double it, that sounds like 100 percent increase to me.

Mr. **Suiter**. We would appreciate anything you gave us, sir.

Senator **Ford**. Well I am asking what would it do? You know, we have to have reasons and most of the time it has to be emotional.

Mr. **Suiter**. Well there are several things we could do and certainly one of the areas we would be working in if we had more money to do it would be urban search and rescue. Those areas where the school buildings are predicted at the 8.0 or greater earthquake at least, to collapse, in terms of search and rescue. How are we going to get these people, children or whoever else, out of the buildings. As we saw in Mexico City, the collapsed hospitals and some of those activities, and that is not to say that in less than a 6.0 that ours would. We do not know that yet, but it would help them identify for us that.

It would help us set up a better disaster intelligence system, better communications systems that can survive the activity and also help us survive in the multi-state area. Remember that even though California has the greater threat than we do, they are at least in one state. We are in seven states with seven governors, seven legislatures, 14 United States Senators, 149 Congressmen and 28 million people, 516 cities and X number of counties. There are a lot of political jurisdictions——

Senator **Ford**. Would you write that down for me, I did not quite keep up with you.

Mr. SUITER. I will be delighted to write it down for you, sir, I say it a lot.

Senator FORD. With that kind of group though, it is a good core group to begin to move.

Mr. SUITER. It is a good start and my friend, my guardian angel as we call him, Mike Kernell, is sitting over on the front row, from the general assembly, who I have to report to for our programs over there, is supporting us at the state level. More financial support would provide funding for earthquake exercises. These are costly things to do. We do not just run out here and throw up an exercise of a nuclear power facility or the Department of Energy, somebody has to pay the bill. There are thousands of manhours involved in these things and we have to pay the bill. This is a national problem, the budget should definitely be doubled or more than doubled, for preparedness. As a matter of fact, if we had had as much money put in the preparedness program as we have had in perhaps a lot of other programs across the country, I cannot imagine how much valuable work we would have accomplished. And we think we have done a reasonably good job as it is.

Too much more needs to be done. There are problems with—thanks to Mike, I am lucky here with the money you just appropriated, $3 million or whatever it is, and FEMA will soon get that down to the states. It is a matching funds program. You were governor at one time, sir, you know even if we get federal dollars in here, if it is in the wrong sequence for when the general assembly is in process, we cannot do anything with it. That means we cannot spend it. In my case, Mike is up here and he will be able to help us. I do not know about the other states, whether they will be in that process or not. So it is a matter of timing in all these things.

But we need the money, yes, sir.

Senator FORD. Dr. Johnston, how much additional research could you do if your budget was doubled? What could we do? I am trying to get a figure here and trying to find some substance or put some meat on the bones that can say this is why we need to go this far.

Dr. JOHNSTON. Well there are a number of very important research areas that simply are not being done now because there is no support to do them. I will mention three. One is the strong motion instruments I talked about. If we do have a magnitude 6, 6.5, that data is, as I said, priceless because that will be our first data for a large eastern U.S. earthquake that the engineers can use to test how they are building better buildings.

We do have a different situation here in the eastern U.S.; we will know much better how large a damage area to expect for a given size earthquake and also how the soils will affect it.

So I would say first the strong motion instruments array. The second would be the use of satellite technology to directly measure the crustral strain. There is slow strain buildup—now that would be a minimum of a decade long project, but if you could directly measure that strain, that is your best handle on actual earthquake prediction itself.

Finally there are a lot of techniques that the oil industry uses to look for structures that are promising for oil recovery that could be used in the New Madrid zone to much better understand its structure.

These are all fairly costly projects that simply are not done because there are not funds to do them.

Senator FORD. Thank you, Mr. Chairman.

Senator GORE. Thank you very much.

Thank you both very much for appearing here today. We certainly do appreciate it.

Let me call our last panel to the witness table at this time. Dr. Richard Hallgren, Executive Director of the American Meteorological Society; Dr. Dallas Peck, Director of the United States Geological Survey and Mr. Grant Peterson, Associate Director for State and Local Programs and Support, with the Federal Emergency Management Agency.

While these gentlemen are working their way to the witness table, let me acknowledge and welcome another local official who is present; Keith Ingram, Mayor of West Memphis, Arkansas, is present today. We are delighted that he could join us along with these other officials who have come today.

Also, while our witnesses are preparing their props here, I would like to take this occasion to express thanks to the people here at the Fogelman Executive Center for their warm hospitality and for their help in setting up this hearing today. I would especially like to mention Sam Braxton the director, Donna Keel, the conference coordinator and Annette Ward on the staff.

I also want to thank the staff at TEMA, especially Danny Newton, who helped a great deal to make this hearing come off well.

And I am glad that Dr. Peck and Grant Peterson could be here, but I would also, in addition to recognizing them, like to recognize several federal officials who are very involved in the earthquake program, who are here today; Richard Wright at the National Institute for Standards and Technology; Robert Hanson from the National Science Foundation which has a great deal of effort going into earthquake research. And Dennis Kwiatkowski from FEMA. Thank you all very much for being here.

We are going to go with Mr. Peterson first and then Dr. Peck and then Dr. Hallgren. Mr. Peterson is with the Federal Emergency Management Agency and is here from Washington. We appreciate your presence here, Mr. Peterson. Please proceed.

STATEMENT OF GRANT C. PETERSON, ASSOCIATE DIRECTOR FOR STATE AND LOCAL PROGRAMS AND SUPPORT, FEDERAL EMERGENCY MANAGEMENT AGENCY

Mr. PETERSON. Senator Gore and Senator Ford, it is a pleasure to be here before you. I have not had the opportunity to be before you before, so I am pleased to have this opportunity to appear before the Subcommittee on Science and Technology and Space to discuss the efforts of FEMA and the states to implement earthquake mitigation and preparedness in the central United States.

In response to your letter of invitation, I would like to present to you today actions we have taken, actions we are taking and our plans for the future with regard to the National Earthquake Hazard Reduction Program, the NEHRP, in the New Madrid area.

Mr. Chairman, my comments are about one quarter of the submitted testimony and I would ask that it be submitted for the record.

Senator **Gore**. Without objection, it will be in the record.

Mr. **Peterson**. FEMA, I believe, has developed an effective but improving relationship with the seven states of the central Mississippi Valley. FEMA began working with these states in 1983 and has provided at this date over $1.2 million to the seven states since that time. Because of this funding and our technical assistance, these states are now much better, by their own admission, prepared to address earthquake hazards, than they were just five years ago.

In 1984, FEMA began funding also, the Central United States Earthquake Consortium, CUSEC. Since then, FEMA has provided over $1.7 million to CUSEC. Initially CUSEC was solely supported by FEMA in its infant days. We watched it grow, this agency, and now it receives additional substantial support from its member states and is forming a very sound foundation of support in the private sector. Mr. Suiter, I think, did not cover some of these areas because he is such a gentleman, but should certainly receive much support for many of the initiatives today in CUSEC. With FEMA's support, this independent, non-profit organization has meaningfully addressed the multi-state issues of the NEHRP in the central U.S.

One of CUSEC's most notable successes has been the implementation of the multi-state interstate compacts. And additionally, CUSEC has also done an outstanding job raising the earthquake awareness level among local officials and decisionmakers through the region.

I would like for just a second to speak to the issue of the U.S. Decade. FEMA has provided technical and financial support to the Decade since its inception. We have provided a senior staff member to work with the U.S. Committee, OSTP, and financial support.

Virtually everything I believe that we do in State and Local Program and Support and the Federal Insurance Administration (FIA) in FEMA support the goals of the Decade. Technical assistance can be just as important in this day and age as financial assistance. Demand for the publications comprising FEMA's earthquake hazard reduction series has been significant throughout the nation and the central United States is no exception, and there has been a strong demand internationally.

Similarly, FEMA has provided the states within the midwest with the vulnerability assessment data necessary to initiate mitigation preparedness and response planning activities. Perhaps the best known of these studies is the estimate of the impacts of the major earthquakes in the six various sized and situated cities in the central U.S. I would add that we are now extending these study efforts to include the St. Louis area.

At this point, Senator, I want to acknowledge and thank you for your efforts in increasing the funding and the support to the NEHRP as part of the recent continuing resolution. All of the agencies of the NEHRP gratefully accept the challenge and responsibility that does accompany these funds, sir.

The $3 million provided to FEMA will meaningfully enhance earthquake preparedness and mitigation in the central United States. As you know, FEMA provides the only continuing financial assistance under the NEHRP that goes directly to state and local governments to build and implement effective earthquake mitigation, preparedness and response programs. Our added funds will be used for this purpose and we will convene a meeting with representatives of the states to ensure that these funds will be effectively utilized, and the central United States representatives will be key participants providing their knowledge and their perspectives, sir.

I might add that the $3 million that has been designated for FEMA will double the amount of money that we now have available to go to state and local governments. So we are very appreciative of that act, as the states should be as well.

In addition, recent Congressional initiatives, notably your S. 1062 and H.R. 3533, provided evidence of Congressional intent to accelerate almost all elements of the NEHRP. One specific area deals with determining the adequacy of search and rescue. FEMA is already aggressively pursuing enhancements of the national urban search and rescue capability by scheduling a national workshop in Seattle in late January, the invitations are out and there is a strong response to those invitations, sir. This is only one part of a two-year effort to identify existing capability, determine shortfalls and needs with an end result to inventory, train and certify a national resource of urban search and rescue teams.

The earthquake hazard and earthquake losses stem from the built environment, as we have heard here in great detail today. We work with the building community to develop and put into practice improved seismic design and construction techniques and standards. FEMA has an ongoing cooperative project with the Building Seismic Safety Council, the BSSC, and we owe them, all of us owe them, a great debt. Their work has been exemplary and they work with the building officials, as we do, to improve seismic design and construction of new and existing buildings throughout this nation.

The NEHRP recommended provisions for new buildings, which we have broadly promulgated, are in the process of being incorporated into model codes applicable nationwide. The issuance of these provisions is of itself a notable accomplishment for FEMA and for its partners. Right here in the City of Memphis in Shelby County in the State of Tennessee, they are all taking major steps to include seismic risk in their building codes, as we have heard.

We also engage in cooperative projects with the private sector and voluntary organizations to promote earthquake awareness and education. A good example of this is our work with Sesame Street to develop the Big Bird Get Ready for Earthquake Kits, which have been widely distributed in the central United States.

Mr. Chairman, of the $4.5 million in program funds that we have, $500,000 of that goes directly for education. There have been many questions related to that today.

In the area of response, we work with 25 other federal agencies to coordinate the federal response to a catastrophic earthquake. I chair that committee and its operations detailed in the plan for the federal response to the catastrophic earthquake. The plan sets up the policy, the operational structure and the duties of 25 federal departments and agencies. This plan has been exercised four times in the past five years; 1984, 1985 and 1988, and most recently in August, 1989 in Response 1989. Needless to say, we also called that group together in Loma Prieta and it worked well.

The federal earthquake response planning in the central U.S., I believe, must address the potential for serious damage occurring in a multi-state basis. That is much more problematic than we are seeing in the focused resources and capabilities of individual states. FEMA, therefore, has developed a regionwide planning strategy that is flexible enough to adjust to individual state's response and to their needs.

A series of workshops and seminars and exercises are planned for the central United States to refine our response planning and operation. A tabletop exercise will be conducted in 1991 when we will also be developing a full scale exercise scenario and plan for this area which will be exercised in 1992. Now that will be very similar to what we did in Response 1989. We will have 25 federal agencies respond to that as well as the Red Cross, over 600 federal employees will be responding to the needs of the seven state managers in this area.

Mr. Chairman, in 11 weeks we have responded to nine Presidential Major Disaster Declarations in FEMA, including Hugo and Loma Prieta. We have registered over 330,000 people through our disaster application centers for assistance and have allocated over $2 billion for assistance programs. We have initiated a program to be sure that the lessons learned from these events are captured and will be of benefit to the federal agencies, the state and local governments, in preparedness and response. Those teams are now in Puerto Rico, St. Croix and will be in South Carolina tomorrow for two days making those assessments and then on to North Carolina and California.

As the agency designated by Congress to lead the NEHRP, we also collaborate with other principal agencies to work toward accomplishing the goals of the national program, a reduction of earthquake hazards in this country. In this regard, I would like to close today by speaking with you about our role as lead agency of the NEHRP.

In the past, FEMA has been criticized for its lack of assertive NEHRP leadership. With the concurrence of the acting Director, I am here to tell you that I personally will assure that the priority of the NEHRP in FEMA will no longer be questioned. I am committed to asserting FEMA's legislative leadership role and that is a personal commitment from me to you.

As lead agency, FEMA has several initiatives planned for fiscal year 1990 to enhance the capability of the NEHRP. First, FEMA will be establishing an advisory committee for the NEHRP. We also are planning to convene a national earthquake policy workshop. The purpose of this workshop will be to assemble key policymakers and earthquake experts to discuss major issues confronting the NEHRP today.

I will be working over the next few months to revitalize the policy coordinating group. This group, which I will chair, consists of the leadership of each of the NEHRP agencies. I firmly believe that the membership of this group can greatly assist FEMA and me in our efforts to better coordinate, integrate and establish direction for the earthquake programs for the four agencies. I have been substantially encouraged over the last year in being able to coordinate 25 federal agencies under the catastrophic disaster response group and have seen a spirit and a need and an understanding of the need to have a capable federal agency response organization. I will look for the same cooperation in the policy coordinating group.

I believe we have done a lot in the central United States, but we should not delude ourselves because we have a very long ways to go. FEMA will sustain its commitment to work with the state and local governments here and elsewhere. FEMA is committed to executing its legislative role before, during and after the event, sir.

I would only like to close with one other comment. I believe a comparison of funding is an interesting issue that should be put on the record, over the last 11 years. The Federal Emergency Management Agency has the lead responsibility. The Federal Emergency Management Agency is the primary conduit for funds to state governments and the state is the primary conduit to local governments. We heard the frustrations of the mayors today and the county commissioners. I was a county commissioner for five years before I took this position, I have great empathy for some of the things they said. But I think we are the primary conduit for that.

Over the last 11 years, FEMA has been funded with a total amount of funding of $39 million for 11 years. That is less than $3.3 million per year, to provide funding to the states. the USGS has been funded at $406 million, the National Science Foundation has been funded at $293 million and the NIST has been funded at $5.27 million. I am sure they are very pleased to see your support for them also.

This year we are funded at $6 million, about $4.5 million of that is program money and we have 23 full time employees to carry out the earthquake program. We are going to take it on, and I would ask that I would have access to you in February if at all possible to present to you an integrated strategy for the leadership role that FEMA will play.

Thank you very much. That concludes my comments.

[The statement follows:]

DRAFT

STATEMENT OF THE

FEDERAL EMERGENCY MANAGEMENT AGENCY

Mr. Chairman, I am pleased to appear before this joint session of the Subcommittee on Oversight and Investigations and the Subcommittee on Science, Technology and Space, to discuss the earthquake threat in the Central United States and the actions of FEMA to address that threat.

At the outset, I would remind us all of two points:

First, that FEMA is not just concerned with enhancing preparedness and response capability for an earthquake, but is also concerned with reducing or mitigating our losses from earthquakes. All of FEMA's activities under the NEHRP support development of a capability by the States, local governments and private organizations and individuals to mitigate the earthquake hazard. This is an important point.

Second, that the Loma Prieta earthquake underscored the positive impact the overall NEHRP has had in California and has confirmed that the mitigation programs that FEMA has underway can help prevent life and property loss in earthquakes.

By mitigation I mean, designing and constructing buildings to address the earthquake hazard, public education programs which teach people what to do before and during and earthquake to protect themselves and their property, and planning on how to respond to the event.

We saw first hand how these programs made a difference in California.

However it is critical to remember that this was not a catastrophic earthquake and it occurred in California, the State best prepared to deal with an earthquake because the NEHRP and the State have invested significant resources in earthquake hazards reduction over the years.

If this earthquake had occurred along the New Madrid fault, the impact would have been drastically different because earthquake hazard reduction activities outside of California are not yet a priority.

FEMA essentially has two programs with which it addresses the earthquake hazard.

In the first, the National Earthquake Hazards Reduction Program (NEHRP), FEMA strives to lessen risk in areas vulnerable to earthquakes before the event.

In the second, the Disaster Assistance Program, FEMA works with State and locals to respond and recover once an earthquake (or any disaster, for that matter) has struck.

FEMA's NEHRP activities fall into five categories:

1. Working closely with State and local governments to build and implement effective earthquake mitigation programs. We provide both financial and extensive technical assistance to the States.

2. Working with the building community to develop and disseminate improved seismic design and construction techniques and standards. FEMA and the building community then work with Federal, State, local and private organizations to incorporate these technical advances into their building activities.

3. Undertaking cooperative projects with the private sector and voluntary organizations to promote earthquake awareness and education.

4. Working with 25 other Federal agencies to coordinate the Federal response to catastrophic earthquakes.

Finally, FEMA as the agency designated by Congress to lead the program, we work with the other principal agencies, USGS, NSF and NIST to accomplish the goal of the NEHRP - to reduce the loss of lives and property from future earthquakes in the United States.

As lead agency of the NEHRP, we have looked at the threat from a national perspective and we have taken the lead to bring attention to the need to accelerate earthquake hazard reduction activities East of the Rockies.

In this context, FEMA has been working closely with the States of the Central Mississippi Valley - Arkansas, Indiana, Illinois, Kentucky, Mississippi, Missouri and Tennessee.

These States both individually and collectively are much more ready to address the earthquake hazard than they were just 5 years ago.

FEMA annually provides the only nationwide funding to States to develop a comprehensive capability to deal with the earthquake threat.

In addition , we have joined with these States to support the Central U. S. Earthquake Consortium (CUSEC) whose representative, R. D. Ross, joins us here today.

CUSEC was originally solely supported, financially, by FEMA. It now receives substantive support from its member States and is forming a sound foundation of support in the private sector.

In the 5 - 6 years of its existence, this independent non-profit organization has meaningfully addressed the multistate issues that arise in the Central U. S. as they begin to implement of earthquake hazards reduction programs. Including:

- establishing a Multistate Interstate Compact for a 7 State cooperative response;

- conducting joint earthquake awareness campaigns; and
- convening training and information exchange forums for the 7 States to identify their common and diverse earthquake needs.

FEMA has supported each of these 7 States collectively (as under our contract with CUSEC), and it has also supported them individually, so that they can address their State-specific earthquake hazards reduction needs.

While FEMA provides the needed financial support for these projects, providing technical assistance is equally as important.

We have provided the Central U.S. States with the hazard identification and vulnerability assessment data necessary to initiate State specific earthquake activities.

The Six City Study, incorporating mapping done by the U.S.G.S., provides preliminary estimates of the potential consequences of two major sizes of earthquakes in six cities within or near the seismic zone.

These cities are Little Rock, Carbondale, Evansville,Paducah, Poplar Bluff and Memphis, which are representative samples of cities throughout the Central U.S.

Because these studies are so essential to our work with the States, we extended the study to include St. Louis, Missouri and expect to provide the data included in that study to the States in the next few months.

The States in the Central U.S. have taken significant steps including:

- exercising their generic response plans to allow for preparedness improvements;
- school earthquake education and safety programs, supported also by technical assistance materials developed by FEMA;
- the conduct of State-wide earthquake awareness campaigns, such as an earthquake awareness week, and the production of State-specific earthquake awareness materials; and
- The support of Seismic Advisory Councils such as the one which recently was conducted in Illinois and in which the Governor was able to provide Executive level direction and policy for earthquake hazards reduction in the State.

The progress in the Central U.S. is notable, but it has been affected, as have all the States at risk, by the amount of funds available to support them nationwide.

FEMA's active and aggressive program of seismic design is a critical component in our efforts to work with the States, local governments and the private sector to mitigate the death and destruction caused by earthquakes.

The Federal government does not, and should not impose building standards on State and local governments. It can, however, set an example by providing the tools for these entities to make prudent choices relative to the design and construction of their communities.

For this reason, FEMA has been working closely with the building community to provide these tools. We have made some significant strides in this area.

The NEHRP Provisions for New Buildings, mentioned by NIST earlier, were prepared for FEMA by the Building Seismic Safety Council (BSSC).

These NEHRP Provisions are currently being considered for adoption by two of the Nation's three major model building codes: the Building Officials and Code Administrators and the Southern Standard Building Code.

These two code groups are the predominant model building codes used in the Central U.S.

Once the NEHRP Provisions are incorporated into these codes, it would mean that seismic considerations will eventually be adopted by the majority of the Central U.S. States and localities that traditionally use these two model codes.

With this, the Central U.S. will take a major step toward mitigating the earthquake hazard relative to new construction.

Based on the California experience, we know that the existing building stock is a great threat in an earthquake. This problem is especially critical in the Central U.S. where the building stock is older, contains more seismically suspicious buildings and the effects of an earthquake could be felt over a wider geographical area.

Our approach to this problem has been to provide the tools and technical assistance for a local building official to assess the risk in his own community.

We have developed basically a four step approach for rapidly screening a building stock to identify those that must be dealt with, conducting a detailed evaluation of each specific building to determine the most appropriate retrofit techniques, estimating costs for their seismic retrofit, and determining the priorities of action in a retrofit program.

There are other publications on existing buildings, and many more are planned in our publication series, the Earthquake Hazards Reduction Series.

It was demonstrated in the recent California event that when people are appropriately educated on what to do in an earthquake, they effectively respond to the event.

It is a goal of FEMA to provide a level of awareness and practical information to all of the people in the United States at risk from earthquakes. In many ways, this is all of us.

But we have tried to concentrate many of our efforts on one of our most vulnerable populations - children.

Some of our more well known materials for this audience are the Big Bird Get Ready For Earthquakes kit, an education curriculum for school children developed in conjunction with the National Science Teacher's Association, and a school safety guidebook.

But we also have developed numerous education courses that are available not only in our Emmitsburg facility, but also under field deployment. In fact CUSEC and its member States have hosted many of these courses and they are aimed at specific target audiences such as utility or hospital administrators;

In the event of a catastrophic earthquake in the Central U.S., the Federal response planning supported by the NEHRP and Disaster Assistance Programs will provide the response supplements needed by State and local areas to save lives.

In the Central United States, researchers have estimated a probability as high as 63% for a 6.0 earthquake occurring in or near the New Madrid Seismic Zone before the year 2000. An earthquake of 6.0 can cause, at the least, considerable damage economically - this was shown in the Whittier earthquake of October 1987. And the nature of the geology in the midwest and eastern areas of the country will greatly expand the area impacted by an earthquake.

The focus for FEMA's Federal Response Planning efforts is the Plan for Federal Response to a Catastrophic Earthquake. This Plan details mutual agreements and concerted actions by 25 Federal agencies.

The Plan organizes Federal assistance functionally, each function addressing a critical area in which the federal government will provide resources to supplement those of local and state governments.

The Plan is designed to address the situation resulting from a catastrophic earthquake in which the Federal government is not usually involved i.e. the immediate response phase to save lives.

After the occurrence of a catastrophic earthquake, our precept is that a Presidential major disaster declaration and implementation of the Plan would be immediate.

FEMA would establish a disaster field office to coordinate the Federal lifesaving and life protecting efforts in support of local and state efforts. Within hours, Federal Agencies would deploy staff and resources to staging areas in or near the affected area to provide response assistance.

In the scenario of an earthquake affecting Memphis, the City would coordinate its activities with the State, which in turn defines its priorities for the Federal Government.

In Washington, D.C., FEMA would convene the Catastrophic Disaster Response Group (CDRG) to coordinate national level support for activities in the field.

The Plan is detailed at the regional and risk area level by supplementary plans and procedures specific to the requirements of the agencies in those risk areas and regions. These regional supplements define the Federal/State coordination mechanisms and agreements, the operational procedures, and the administrative and logistical requirements needed in that area.

Earthquake response planning for Central United States presents some unique challenges particularly the capability for catastrophic impact in more than one State.

Based on the location of the two major urban areas of the Central Mississippi Valley and therefore the two high risk/high population areas, a couple of planning groups are being formed to initially identify the regionally specific planning activities:

- a northern planning group based on the St. Louis metropolitan area. FEMA Region 7 (Kansas City) has the lead for the interagency planning and will focus its supplement for the States of Missouri, Illinois and Indiana; and
- A southern planning group based on the Memphis/Shelby County urban area. FEMA Region 4 (Atlanta) will lead interagency planning here for the States of Tennessee, Arkansas, Kentucky and Mississippi.

The Plan addresses the immediate response activities. We envision that the period of life safety, life protecting activity may last for as long as thirty days.

But as immediate response needs are met, normal disaster recovery assistance would become available under the Disaster Relief Act and the programs it authorizes.

FEMA would provide temporary housing and grants to individuals and families and funds for debris removal and to repair or replace damaged public facilities such as roads, streets, and bridges, and public buildings and certain non-profit facilities.

The Small Business Administration would provide loans to individuals and businesses affected by the disaster. Other Federal agencies also provide disaster assistance, such as food stamps and unemployment benefits.

We have had another warning - as if Coalinga, Chile, Mexico City, Whittier and Armenia weren't enough -

A warning which once again tells us we can either take action now or pay later.

This earthquake proved that if we take steps to mitigate the risk, as California has, we can minimize the need for an intensive response.

We can make a difference if we accelerate our mitigation efforts to deal with our unsafe buildings and ageing infrastructure.

I am here today to say, FEMA is committed to doing just that.

Senator GORE. Well we will save questions until the panel is over, but let me respond briefly by saying of course you are welcome to come in and talk with the subcommittee any time. I personally want to cooperate with you. By way of background to some who may not know the sub-text of these final remarks in Mr. Peterson's statement, I and some others on the Commerce Committee wanted to change the lead responsibility for the earthquake program from FEMA to the Geological Survey I still feel that way, but I am delighted that as long as you all have the lead responsibility you are anxious to conduct it vigorously and I certainly have an open mind and am ready to be convinced and persuaded that FEMA is going to take it on with renewed determination and vigor. It is only about one percent of your total mission and you spend an awful lot more time planning for the Russians dropping a hydrogen bomb on us than earthquakes, but that is part of how you got set up and we understand that. The U.S. Geological Survey, by contrast, devotes a major part of its effort to this area.

But competition is good in government as well as in private business and if you feel that competition from the USGS has managed to get more support for FEMA from some of us, then that is good and I welcome the statement of determination you have just made.

Dr. Peak, I think that the USGS has about $34 million this year, most of it directed towards research. That compares to the $6 million that FEMA has in this area.

But in any event, we are delighted to have you here, Dr. Peck, as Director of the United States Geological Survey. Welcome and please proceed.

We are running short on time and if our final two witnesses can summarize their prepared statements, we would appreciate it.

Dr. Peck.

STATEMENT OF DR. DALLAS PECK, DIRECTOR, U.S. GEOLOGICAL SURVEY

Dr. PECK. Thank you very much, Senators. It is a pleasure to be here. I will summarize my remarks very briefly and submit the rest for the record.

I want to start by saying I am accompanied today by Dr. Rob Wesson, who is in charge of our earthquakes, volcanoes and landslide programs and Dr. Walt Hays—a deputy in Wesson's office.

Senator GORE. And charts.

Dr. PECK. Pardon?

Senator GORE. And charts.

Dr. PECK. And charts and the dogs under the bed too. And by Dr. Walt Hays——

Senator GORE. I am not going to live that one down.

Dr. PECK [continuing]. Who has been working in earthquake preparedness and one of our major links with FEMA and State and county organizations through the years.

I want to hit three main subjects; one, natural hazards in the United States with particular emphasis on the Loma Prieta earthquake; our plans for the New Madrid seismic zone and a little bit about the International Decade for Natural Disaster Reduction.

The first graph shows the San Andreas fault and the part that broke during the Loma Prieta earthquake of October 17. In contrast to other San Andreas earthquakes, the movement during the earthquake was both a right lateral movement and an uplift of the Pacific side of the quake.

Since that earthquake less than two months ago, we have published in the past week two reports on the earthquake, a circular entitled "Lessons learned from the Loma Prieta Earthquake of October 17" and a popular publication on what happened, what is expected and what can be done on the earthquake. I would like to submit these for the record along with my written statement.

Before we injure our arm patting ourselves on the back because of the contrast in damage to Armenia in the December 7, 1988 earthquake and to San Francisco during the earthquake, let us keep in mind that the epicenter of the earthquake was 50 to 75 miles away, it was deep, greater than ten miles deep and the duration of the shaking was only six seconds, several times less than the shaking during the Armenian earthquake. Future earthquakes in the Bay area will more likely be closer to San Francisco and of shallower depth.

The earthquake did leave 62 confirmed dead, more than 3,000 injured, 14,000 homeless, 100,000 damaged buildings. The damages, and direct losses are expected to exceed $8 billion from this magnitude 7.1 earthquake.

I would like to take this opportunity to thank you, Senator Gore, for your successful effort to add $20 million to the National Earthquake Hazards Reduction Program.

Senator GORE. Let me interject again that Senator Ford and Senator Gore did this together.

Dr. PECK. Yes.

Senator FORD. He is running next year, so it is all right, he can have the credit.

Dr. PECK. I want to thank you both. It is money well invested for the country; we do appreciate that.

The next board is to remind us that earthquakes are a national phenomenon. The board shows the major earthquake source regions in the United States. Other hazards are also national phenomena; landslides, floods, tsunamis, volcanic eruptions are hazards particularly on the west coast and the island of Hawaii. We need to be prepared for all the hazards.

Our programs in these areas are carried out in cooperation with the States and local governments, universities and the private sector.

Many of the program goals are shared with FEMA, the National Institute of Standards and Technology, and the National Science Foundation.

And like you, Senator, we welcome aggressive leadership in this program whether we provide it or whether FEMA provides it and I welcome and am enthusiastic about your comments in this area.

Senator GORE. That is coming through.

Senator FORD. We were on different sides here. We are not fighting, we are trying to cooperate.

Dr. PECK. Neither are we, we just want good leadership, that is all.

The next board shows the New Madrid seismic zone. We have heard Dr. Arch Johnston describe in some detail what the hazards are and what we know and what we do not know. We clearly need to know more about this zone of seismicity.

At the direction of Senator Gore, Senator Ford and several other Senators, we convened a workshop in October that Dr. Johnston summarized to address what needs to be done for the New Madrid seismic zone as far as reduction of risk from future earthquakes. And there are five points to that program, if we could have the next slide.

One is modernization of existing regional earthquake monitoring networks. That is very important in pinpointing the zones of the fault where the movement is hung up and where there is a likelihood of future earthquakes.

Location and characterization of the fault zones that can cause destructive earthquakes.

Delineation of areas of potential damage from strong ground shaking and ground failure, and that includes strong motion instrumentation.

The improvement of the seismic risk assessment in major urban centers, what is going to be damaged during a magnitude 6 to 6.5 earthquake.

And importantly, the transfer of information to local government agencies, private organizations and so on.

So this expanded study of the central Mississippi Valley region would be carried out under the National Earthquake Hazards Reduction Program and in connection also with the International Decade for National Disaster Reduction. We will see cooperative programs with the other agencies. The ultimate responsibility for loss reduction, however, resides, at the community level where seismic safety policies are adopted and implemented. So it is particularly important in this meeting to have representatives from that community.

Just a final note on the International Decade. I learned this morning that a resolution passed this morning in the important second committee of the U.N. General Assembly. The United States is one of 155 nations including the United Kingdom and West Germany, to cosponsor that resolution. I have been involved as the chairman of the Committee on Earth Science and could respond to questions about that if you so desire.

Thank you.

[The statement follows:]

STATEMENT OF DR. DALLAS L. PECK
DIRECTOR, U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR
BEFORE THE
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE
DECEMBER 11, 1989

Mr. Chairman, I am pleased to appear before this session of the Senate Subcommittee on Science, Technology, and Space to discuss the important role that the earth science programs of the U.S. Geological Survey (USGS) continue to play in improving disaster preparedness and mitigation applications throughout the Nation.

In my presentation, I will describe the plans of the USGS for increasing fundamental understanding of the New Madrid seismic zone, the source of three great earthquakes having magnitudes of 8.4 to 8.8 in the winter of 1811-1812 and thousands of aftershocks. Such understanding is critically important for improving earthquake preparedness and mitigation applications in the Central Mississippi Valley Region.

In addition, as Chairman of the Committee on Earth Sciences (CES) of the Federal Coordinating Council on Science, Engineering, and Technology, I will discuss how science agencies of the Federal Government plan to work together to reduce loss of life and economic impacts from a wide variety of natural disasters. The Nation's effort will be marshalled during the 1990's as part of the International Decade for Natural Disaster Reduction (IDNDR), a period of concerted worldwide effort to expand the scientific and technical knowledge base and accelerate its use in disaster preparedness and mitigation applications.

The USGS has ongoing national and international programs which encompass research, preparedness and mitigation applications, and technology transfer. The USGS's programs in the United States have been designed to produce knowledge needed to reduce loss of life and economic losses from the physical effects of earthquakes, floods, landslides, volcanic eruptions, and tsunamis. These programs are being carried out in cooperation with other Federal Agencies, State and local governments, universities, and the private sector in every hazard-prone region of the United States: California, Alaska, Hawaii, the Northwest, the Intermountain area, the Gulf Coast, the Mississippi Valley, the Great Lakes, the Southeast, the Northeast, in Puerto Rico, and the Virgin Islands. On the Federal side, many of the program goals and activities are shared. For example, Federal Emergency Management Agency (FEMA), National Institute of Standards and Technology (NIST), and National Science Foundation (NSF) share responsibilities with the USGS in the National Earthquake Hazards Reduction Program (NEHRP).

In recognition of the fact that knowledge alone makes no contribution to the reduction of earthquake losses if it is unaccepted, misunderstood, inappropriate, unintelligible, misdirected or ignored by practitioners, we have convened more than 50 workshops during the past 12 years--an average of 1 every 3 months. These workshops, often convened in cooperation with FEMA or NSF, have been successful in transferring information, products, and technology to a wide variety of researchers, practitioners, and public officials in every part of the Nation.

Products produced by the USGS in the NEHRP have been used to improve earthquake preparedness and mitigation applications throughout the Nation. Both preparedness and mitigation activities are initiated well in advance of the event. Preparedness, which enables emergency managers to deal effectively with the requirements of the response and recovery periods, encompasses the following:

- development of a planning process to produce emergency response and recovery plans that are based on the best available scientific and technical data.
- use of information acquired from instrument networks to increase hazard awareness and to warn the populace of impending events.
- dissemination of information on earthquake hazards and risk.

Mitigation, which has the goal of reducing or preventing damage and societal disruption, encompasses the following:

- development of realistic scenarios of potential losses and societal impacts for one or more possible events in order to identify vulnerable buildings and infrastructure in a community.
- reduction of vulnerability to the inventory of buildings, facilities, and lifelines (e.g, energy, water, transportation, and communication systems) at risk in a community.

- development of seismic zonation (i.e, the division of a region into areas expected to experience the same severity of a hazard).
- adoption and implementation of codes and standards for the siting, design, and construction of new buildings and lifeline systems and the strengthening of existing buildings and lifelines.

The Central Mississippi Valley is the focus of an expanded USGS program. Special FY-90 funding provided after the October 17, 1989, Loma Prieta, California, earthquake is being used to initiate a 5-point program that will save lives and reduce losses from future earthquakes in the Central Mississippi Valley. The program, which was developed by 50 participants from the region in a workshop the USGS convened in Memphis, Tennessee on November 15-16, has the following elements:

- modernization of the existing regional earthquake monitoring network in order to provide an authoritative record of earthquake activity in the region.
- location and characterization of fault zones that could cause destructive earthquakes.
- delineation of areas of potential damage from strong ground shaking and ground failure expected to occur in future earthquakes.
- improvement of seismic risk assessments in major urban centers for magnitude 6.0-6.5 earthquakes, which occur every several decades.

- transfer of earthquake information to government agencies, private organizations, and practitioners through publications, training, and education in order to improve the capability to implement earthquake preparedness and mitigation applications.

This expanded study in the Central Mississippi Valley Region will be carried out under the auspices of the NEHRP in which preparedness and mitigation applications are the responsibility of FEMA, NIST, and NSF. Research on the nature and geologic effects of earthquakes are the responsibility of the USGS and NSF. However, the ultimate responsibility for loss reduction resides at the community level where seismic safety policies are adopted and implemented. As in the past, we will take specific steps to inform communities of the results of our work and how it can be applied to reduce potential losses.

In 1989, the United Nations declared the period 1990-2000 to be an International Decade for Natural Disaster Reduction. Since then, some 35 nations, including the United States, have established national committees and have begun work. The United States Congress passed resolutions in the 100th Congress, second session, calling for United States participation. Within the Executive Branch, the President's Science Advisor requested that the CES recommend the appropriate actions for the United States. To accomplish this objective, the CES formed a Subcommittee on Natural Disaster Reduction in February 1989. This subcommittee, chaired by Dr. William Hooke of the National Oceanic and Atmospheric Administration, has worked closely with the National Research Council of the National Academy of Sciences to develop goals and objectives for United States participation in the IDNDR.

On October 25, 1989, in conjunction with the 44th General Assembly of the United Nations, Mr. A. Gordon MacArthur, United States Mission to the United Nations, stated:

> "The United States supports the goals and objectives of the proposed Decade for Natural Disaster Reduction, although we are concerned about the resource implications of such a decade ..."

More than 100 nations are expected to adopt a resolution in support of the IDNDR during the 44th General Assembly of the United Nations.

The Subcommittee on Natural Disaster Reduction is proposing the following recommendations for consideration by the CES:

- the science agencies of the Federal Government should work together with other agencies having responsibility for emergency response and recovery to realize the goals and objectives of the IDNDR.

- the Nation's program should be designed to achieve a deeper understanding of:

  a) the physical character of the hazardous events, including the nature of the cause and connections to larger-scale and longer-term processes that determine their predictability.

  b) the role of engineering practice in siting, design, and construction of hazard-resistant buildings and lifeline systems.

c) the opportunities for societal action, including incorporation of hazard and risk assessments into community development plans, hazard safety policies, preparedness and mitigation applications, and financial incentives such as insurance.

o The Nation's program should emphasize:

a) anticipation rather than just reaction to disasters.

b) continuous integration with time of preparedness and mitigation applications which are independent of hazard, geographic boundaries, and organization.

c) coordinated action among a variety of agencies having individual program responsibilities for research and development, policy formulation and regulation, education and awareness, prediction and warning, emergency management, and recovery and reconstruction.

d) a Federal Program Office for the IDNDR should be established to carry out daily activities.

e) a coordinating mechanism such as the Committee on Earth Sciences of the Federal Coordinating Council on Science, Engineering, and Technology should be established.

I anticipate that the CES will adopt most of these recommendations and advise that they be forwarded to the Office of Science and Technology Policy in the framework of a government policy on the IDNDR.

At the present time, the Nation is experiencing annual losses of approximately $17 billion from the natural hazards being considered in the IDNDR. Two recent natural hazards, Hurricane Hugo, a class 4 storm that swept through the Caribbean before striking the Charleston, South Carolina, area on September 17-22, 1989, and the magnitude 7.1 Loma Prieta earthquake that struck northern California on October 17, 1989, are grim reminders of the destruction and societal impacts that can result in a matter of a few days (the hurricane) to a fraction of a minute (the earthquake). Together, these two events caused direct economic losses of approximately $15 billion, left 100 dead, and thousands injured and homeless. The recovery period is still underway in both areas. The relatively small loss of life was due mainly to the successful warning and evacuation carried out for hurricane Hugo and the advanced state of disaster preparedness and mitigation (i.e, emergency response and implementation of building codes and standards) in place in California before the earthquake struck.

In a re-evaluation of earthquake probabilities along the San Andreas fault, published in July 1988, the USGS advised public officials and others throughout California that the Santa Cruz segment of the San Andreas fault system, the segment that ruptured at 5:04 p.m., P.d.t., on October 17, had a 30 percent probability of generating a magnitude 6.5 or greater earthquake during the period 1988-2018. This information was incorporated in preparedness planning.

In summary, during the 1990's, the USGS plans to contribute to the goals of the IDNDR through its ongoing programs in every part of the Nation. In addition, through the USGS's Office of International Geology, technical assistance will be offered to other nations on:

- research to increase basic understanding of the physical processes so that accurate hazard and risk assessments can be made in a timely manner, and when possible, short-to intermediate-term predictions.

- development of reliable prediction and warning systems to advise the populace of impending disaster.

- creation of a comprehensive data base on natural hazards for sharing with others involved in research, education, preparedness, mitigation, response, and recovery.

- ways to improve siting, design, and construction practices.

The scientific information and the influence and experience of the USGS is vital to the success of the Nation's disaster and mitigation applications.

The Nation will benefit by realizing significant reductions in economic losses and loss of life as a result of these national and international activities.

This concludes my formal statement, Mr. Chairman. I will be pleased to respond to your questions.

Senator GORE. Thank you very much.

Our final witness today is Dr. Richard Hallgren, Executive Director of the American Meteorological Society in Boston.

We are delighted that you could join us today, Dr. Hallgren.

STATEMENT OF DR. RICHARD E. HALLGREN, EXECUTIVE DIRECTOR, AMERICAN METEOROLOGICAL SOCIETY

Dr. HALLGREN. Thank you, Mr. Chairman. I shall be brief as you requested.

First of all, I wanted to just say a couple of words as Chairman of the U.S. Committee in the Academy of Sciences on the Decade for Natural Disaster Reduction on where we are in the planning of the national effort and the associated international effort. And second, inject a little bit beyond earthquakes into this discussion since this area has many other natural hazards in the atmospheric and hydrologic area.

We are all very excited about what is happening in the U.N. As Dallas Peck just reported, the resolution is coming through in fine shape, there is an enormous number of sponsors and I think there are great opportunities to really make real progress in coping with natural hazards across this world of ours. And it is not just the large ones, the Hugos, the Armenias, the California. It is the many, thousands of small ones that cumulatively take an enormous toll. We think that great progress can be made both internationally and nationally in the coming decade through a dedicate effort to reduce the toll of natural disasters.

We have many opportunities as Frank Press made the call in 1984. I hope the whole world gets behind it and I hope this nation gets behind it. I think what we have heard here this morning shows substantial progress.

In the National Academy Committee, we are in midstream right now, Mr. Chairman. We are not prepared to specify what we are going to say, but we are going to try to say something useful, intelligent and constructive by early next summer when we report out with some recommendations of what should be done.

I might add that we will have to, if we do our job right, make recommendations in all the areas; prediction and dissemination, preparedness activities, awareness and education and mitigation. In other words, we have to have more action that we have had to date on all fronts, if we are really going to penetrate this problem that is so important to so many people.

Now a few words on the atmospheric and hydrologic hazards; these are my own personal comments. I think this nation is making great progress now and we are really poised to move forward very substantially in providing much higher quality warnings for both severe weather and flooding in the 1990s. I picture this happening in two stages; first of all, the effort to put new technology to work across the country in terms of satellites, radar, automatic stations distribute the processing equipment and large computers, really is going to make an enormous difference in the quality of the warnings, the timeliness of warnings and the advance warning that we will get related to tornadoes, hurricanes, flash floods, winter storms and the like.

We have another step, and I have mentioned this before you in testimony several weeks ago, to take. It is a significant research effort to obtain the full benefit of the technology that we are putting in place. And it turns out that this technology makes the research possible because you are obtaining the observations for the first time of the small scale motions in which these disasters and natural hazards take place. So I really would recommend that this nation complete the technological modernization of the weather service and move forward with an aggressive research program on these small scales because it will move us up one more plateau before the end of the decade.

It is hard for me to add much to the preparedness efforts that have been said today, but I do want to say a couple of words. The preparedness is just all important. The entire period I was Director of the U.S. Weather Service it was so clear to me that every time we had a major natural event and did a disaster survey, it was how well was the area who prepared, how well the local communities, in cooperation with the state and federal level, had they done with their preparedness activities. If they had prepared well that determined the effectiveness of the warning system. If we had much less loss of life and far less suffering of the people. The effort and the dollars that are being spent in this are very, very small. Frankly they are just flatly too small and this nation can afford more than we are presently doing.

We have 3,000 counties across this country that need to have solid preparedness plans. The present investment that has been talked about here would leave a few thousand dollars for each county, and we certainly can afford more than that in my opinion, while still being pretty conservative in all my views.

So I do believe that it is time that we get on with a national focus on preparedness planning for natural disasters. We should shift our emphasis away from frankly the nuclear attacks, spend that money in this area. That decision alone will go a long way toward a national effort. I happen to believe that FEMA can do that job cooperating with all the other agencies and pulling them together as just indicated by Mr. Peterson. I hope we can get on with it. Let us give them the chance to do it right and give them the resources to do it right and really press forward.

Thank you.

[The statement follows:]

STATEMENT OF
RICHARD E. HALLGREN
EXECUTIVE DIRECTOR
AMERICAN METEOROLOGICAL SOCIETY
BEFORE
THE SUBCOMMITTEE ON SCIENCE TECHNOLOGY AND SPACE
UNITED STATES SENATE
DECEMBER 11, 1989

I am pleased to provide some thoughts on the opportunities that exist to reduce the enormous impact that natural hazards have on the people of this world.

THE INTERNATIONAL DECADE

Natural hazards take a tremendous toll each and every year. We all recall recent major natural disasters--Hurricanes Hugo and Gilbert, earthquakes in California, Armenia and China, floods in Bangladesh, and wildfires in Yellowstone. These are the ones that we see on television and read about in the newspaper. But each year, planet earth experiences countless natural events; 100,000 or more thunderstorms, 10,000 floods, thousands of tornadoes, earthquakes, wildfires and landslides, and hundreds of volcanic eruptions and tropical cyclones. It is estimated that in the last 20 years, 2 to 3 million people have died from natural disasters and approximately one billion people have been adversely affected in some way by them.

While we can never reduce the impact completely, much can be done to reduce both the loss of life and the destruction of property. The time is right--scientifically and technologically--for a major effort in this nation and internationally on natural disasters.

Our physical understanding of hurricanes, tornadoes, floods, earthquakes, landslides, and other natural hazards has grown tremendously over the last couple decades. We now have the capability to identify areas at risk from and/or warn them in advance of these hazards. Our understanding of the way people respond to warnings has also been expanded substantially. We have made enormous advances in our ability to detect hazards with satellites, radars, and automatic seismic and weather stations and to communicate and process data very rapidly. Our engineering capabilities on how to design and build hazard resistant buildings have come a long way as well. We are poised to make even greater advances in these areas in the coming decade.

The International Decade for Natural Disaster Reduction can apply existing scientific and technical knowledge for the good of all people. The General Assembly of the United Nations, has under final consideration, a Resolution to initiate the Decade. Approximately 150 nations are co-sponsors of the Resolution. The United States obviously must play a major role in the implementation of the Decade. We can share our knowledge and capabilities with other countries and learn from them as well.

PLANNING THE UNITED STATES' DECADE

The planning of the United States activities for the Decade is now underway. The federal government has an interagency group developing plans and the National Academy of Science has organized a committee to help in formulating an overall national program. The program is complex because it involves so many groups--all levels of government, volunteer organizations, professional groups and the private sector--and so many different areas of activity. The major areas of research and operations that are being considered by the Academy Committee are: risk assessment; mitigation activities; awareness and education; predictions, warnings, and dissemination; preparedness planning and emergency response; and post-disaster evaluation and recovery. We are now identifying actions in these areas that can be taken nationally and internationally. It is clear that actions in all of these areas will be required to reduce the toll that is taken by natural disasters. The committee plans to have an initial report completed by late spring or early summer of next year.

SEVERE WEATHER AND FLOOD WARNING SYSTEM

I will focus my thoughts today on atmospheric and hydrologic hazards. In the aggregate, this nation has more severe weather and flooding than any nation in the world. Although the loss of life from these hazards has dropped substantially during the last couple of decades, property damage has grown substantially.

The nation already has underway a major effort to improve our severe weather and flood warning system. It has the support of both the Executive Branch and the Congress. This effort includes new geostationary satellites, a national doppler radar system, a national automated weather observing system, a new weather information processing system for each of the weather offices across the country, and a new generation of supercomputers at the National Meteorological Center. Initial operation of some systems will begin in late 1990 and with continued support, they should all be in operation in the mid-1990's. This technology, combined with a highly professional core of meteorologists across the country, will provide the United States with the best severe weather and flood warning system in the world.

The full benefits of the technology, however, will come only with new advances in the scientific understanding of severe storms. The next step must be a national research effort involving research laboratories and the university community aimed at increasing our understanding of physical processes associated with hurricanes, tornadoes, flash floods, and winter storms, and improving short-range predictions. A plan for this program has already been developed, but the nation has not yet made the decision to mount this national effort. I believe that it is imperative that we move forward with the program which will lead to further significant increases in the capability of our severe weather and flood warning system.

The dissemination of severe weather and flood warnings has improved markedly in this country in the last decade. The weather service is working closely with local emergency managers and has improved its national weather radio network. But the greatest advances have come in the private sector. The array of television weather broadcasts across the country has improved tremendously. The Weather Channel now provides local warnings 24 hours each day. Radio stations are providing weather forecasts and warnings in a more timely way. But we still must continue to improve our dissemination efforts so that an individual can readily obtain a warning at any time of the day irrespective of what he is doing.

AWARENESS, PREPAREDNESS AND EMERGENCY RESPONSE

Effective warnings and adequate dissemination are necessary, but not sufficient, to reduce the risk of natural hazards to the people of this country. The people must also be able to understand the warnings and know what actions they should take to enhance their safety. We must have more education concerning natural hazards in our curricula at the elementary and secondary schools. We must also encourage more local community action, and more generally, we need to have continuing education through TV and radio to increase the awareness and knowledge of our people about natural hazards. As part of the decade, we must find ways of bringing this about.

Preparedness planning is an extremely important part of protection of life and property. Time after time, during the period when I was

Director of the National Weather Service, disaster survey reports showed that if a city or town had given serious attention to their preparedness effort, then the warnings of the weather service were much more effective in saving lives and reducing destruction to property. This is also true for other disasters. The fact that the San Francisco/Oakland area had developed preparedness plans including emergency response, and had exercised them, led to a reduction not only in the loss of life but in the suffering experienced by the people. In the case of Hurricane Hugo, it was clear that the preparedness plans to effect evacuation as required were well in hand. However, it is not so clear that the emergency response plans were adequate. It seems to me that if there had been coordinated local, state and federal plans that had also been exercised and tested, we would have avoided some of the problems that apparently took place as part of the recovery.

There is no doubt that we have made substantial progress in preparedness planning during the last two decades. It is true that most cities and counties have formulated preparedness plans. However, the quality of the plans varies over a very wide range. While preparedness planning is primarily the responsibility of the local communities, the states and federal government must be deeply involved as well. I believe that a national focus in preparedness planning is essential. The plans should be done on a multi-hazard basis and cover the actions to be taken before, during and after a disaster.

At the federal level, there are many agencies involved in awareness, preparedness, emergency response and mitigation activities. However, we must have an agency that takes the lead in coordinating and fostering these activities throughout the nation. That agency should be, in my opinion, the Federal Emergency Management Agency. To do this, FEMA must receive greater policy attention from both the Administration and the Congress so that it will have the leadership and the resources to fulfill this important role related to natural disasters. Without a stronger FEMA, a program to reduce the impact of natural disasters will, in my opinion, falter.

Dedication of the 1990's to a program whose goal is to reduce the loss of life, the degree of suffering of people, and the loss of property resulting from natural hazards both nationally and internationally, is an extremely important step to take. We must find a way of bringing all groups involved in this together. I believe it can be done. In fact, I believe it must be done.

Thank you.

Senator GORE. Thank you very much. Let me just pick up on that last comment for my first question.

Mr. Peterson, FEMA's budget is about $800 million, correct?

Mr. PETERSON. That is in the ball park.

Senator GORE. It varies because of the number of disasters, but several hundred million. I know you do not publish a specific line item, but in general several hundred million dollars of that goes to preparing for a nuclear war, correct?

Mr. PETERSON. There are really two areas we need to talk about here. There is about $155 million that falls under my directorate which is the civil defense preparedness for the United States. The other side of it should be talked about in a different arena, but the $155 million I think is considerably misunderstood. There is much discussion, as we expected, on transferring those funds from the civil defense arena, which comes out of the Department of Defense 050 account and is directly responsible to the Civil Defense Act.

It is important to note out of that money that there is about $130 million in program money, three dollars out of every four of those goes directly to the states, three dollars out of every four, for the purpose of developing command and control capabilities, survival crisis management capabilities which we saw in Hurricane Hugo and to a less degree Loma Prieta. Tremendous stressing of the communications warning and survival command and control capability.

Senator GORE. Uh-huh.

Mr. PETERSON. Sixty million dollars goes directly to the states to hire and supplement the hiring of emergency managers throughout this United States in about 2500 localities. Those are the largest blocks of money going into emergency preparedness for all hazards including nuclear attack that I believe the federal government is putting anywhere.

So it is just a clarification of a point, sir.

Senator **Gore**. Yes, but in addition to the 155 million dollars, there is a substantial additional sum that also goes into preparing for the aftermath of a nuclear war, correct?

Mr. **Peterson**. That is right, continuity of government and things of that nature.

Senator **Gore**. All right. So you have got several hundred million dollars going to prepare for the aftermath of a nuclear war, and you have only one million dollars for severe weather and wind programs, correct?

Mr. **Peterson**. Correct.

Senator **Gore**. And you have six million dollars for your earthquake program, right?

Mr. **Peterson**. That is correct.

Senator **Gore**. Okay, as the perceived threat of an all-out nuclear war with the Soviet Union subsides somewhat, does it make sense to spend a little more on preparing for hurricanes and earthquakes and the kinds of things that happen year after year and cause billions of dollars worth of damage and maybe a little less on getting a game plan for what we are going to do after a nuclear war occurs?

Mr. **Peterson**. I think that we have to look at the threat that the United States has today and the reality—and this is a perspective of mine, sir—the reality of what is the lessened threat in actual weapons pointed to this country today, how many less do we have today than we had last year or the year before, the fact that other nations have just launched nuclear capable intercontinental ballistic missile systems that were not there a few years ago, and a result of the spinoff from these expended funds that make a stronger emergency capability in normal times.

The United States Government spends about 57 cents per capita per year on the protection of its population in the event of a nuclear confrontation of heightened tension.

Senator **Gore**. Uh-huh.

Mr. **Peterson**. That is only exceeded in lesser amounts by one nation in the nuclear environment and that is France with around $14.80 being spent by the Soviet Union.

I could not, in good conscience at this point in time, say that I believe that that category is anywhere nearly satisfactorily supported. While I would support, in the strongest of terms, that in the area of natural and technological hazards there needs to be a substantial enhancement of resources for the response, mitigation and preparedness of dealing with these catastrophic events, sir.

Senator **Gore**. How long has it been since FEMA had a director?

Mr. **Peterson**. Well, sir, we have an acting director. Julius Becton left on June 24, sir, being specific.

Senator **Gore**. To be even more specific, Julius Becton informed the administration that he was going to leave a little more than a year ago, just around the time of the election in November, 1988 and no one has been nominated to fill his post, correct?

Mr. **Peterson**. That is correct, sir.

Senator **Gore**. Now there are eight top positions at FEMA. Out of the eight top positions at FEMA, we have nominees to fill how many of those eight positions?

Mr. **Peterson**. We have one nominee and one confirmed by the Senate, sir, out of those eight positions.

Senator **Gore**. So we have one out of eight. What is the delay on the other seven, including the director? Why has it been more than a year—let me rephrase the question, because you are not the one on the spot here, your workload has been increased because of what I am asking about and I am trying to put this administration hat on you and it is not fair to you.

Let me rephrase that.

Senator **Ford**. He is getting paid by them.

Senator **Gore**. Is it not a matter that ought to concern this Committee that it has been more than a year since the election, and no one has been selected to run FEMA. FEMA is the agency that is supposedly in charge of the earthquake program and a lot of other disaster preparedness programs as these people from around the central United States who have come to in Memphis for this meeting know quite well. Your agency is supposed to be leading the way yet and it has been more than a year, and a new head of the agency has not been nominated and seven out of the eight top positions have been vacant.

Now is that not causing some problems at FEMA?

Mr. **Peterson**. Well I——

Senator **Gore**. Is that not having an effect on morale at the working level and increasing the workload of people like you?

Mr. **Peterson**. Well I have a personal vested interest in your question, sir, there is no doubt about that.

Senator **Gore**. All right.

Mr. **Peterson**. However, I would say this about morale. It comes out of time of crisis, and the five major disasters that we had in four weeks challenged this agency to the maximum and I have seen a spirit of cooperation and giving that is absolutely unparalleled in my experience as an elected official or as a businessman, and I think the morale is pretty good. So I would speak specifically, I do not believe we have a morale problem.

All of us are looking forward to what we believe are the imminent responses of the Office of Presidential Personnel. I could use my crystal ball and try to give some prophecies but there is an old saying, sir, that is he who uses crystal balls often eats glass. And I think if I got much farther in this one, I might eat some glass. So I would like to leave it at that if I may, sir.

Senator **Gore**. Well if I did not think it would hurt him, I would recommend Lacy Suiter to be nominated to head FEMA.

Mr. **Peterson**. I thought you had already done that.

Senator **Gore**. You thought I had already done that.

Mr. **Peterson**. Yes, sir.

Senator **Gore**. Well I have tried to do it in a way that would not hurt him.

Anyway—Dr. Hallgren, on the International Decade of Natural Disaster Reduction, we are in an unusual position in the United States where the head of our National Academy of Sciences came up with this idea, this wonderful idea, for savings lives, thousands of lives. There are many clear examples where thousands of lives could be saved with a concerted effort at hazard mitigation. The head of our National Academy of Sciences made the recommendation and, other countries around the world have picked it up and run with it because, they think it is a great idea. General Secretary Gorbachev has endorsed it, embraced it and called for cooperation between the Soviet Union and the United States specifically on this subject. Yet our own government seems to be the most reluctant to have anything to do with it.

Is that a faulty impression? I have certainly gotten that impression. If it is true, why would that be the case?

Dr. **Hallgren**. Well since I am not in the administration, I am on the outside that is a bit difficult for me to answer, but first of all, I believe Dallas said the United States has cosponsored the resolution and that is great, that is a good sign. It is a real positive sign.

Senator **Ford**. Has the United States cosponsored this in the U.N.?

Dr. **Hallgren**. Yes, now they have.

Senator **Ford**. They abstained from voting on it previously though.

Dr. **Hallgren**. Yes. They were not lightning fast in joining it, that is true.

Let me say that I really do not believe, although I do not know it was because of the subject of natural disasters, I think it was the fact that this country has not been exactly enamored with International Decades on a general basis. At least I am hoping——

Senator **Ford**. Well the Japanese are. We had better get ahold of it.

Dr. **Hallgren**. So I hope this is a real positive sign that we are now moving in the right direction and Dallas Peck who is still in the government can move forward.

Senator **Gore**. Do you have a comment on this, Dr. Peck?

Dr. **Peck**. Yes, I would like to comment. I am familiar with what is going on from two viewpoints. One, as Director of the Geological Survey, I sent my Assistant Director for Engineering Geology, Jim Devine, to Geneva a year ago in partnership with the National Academy of Sciences and the U.N. to help define what should be the International Decade of Natural Disaster Reduction. So we, the Geological Survey, are very interested in it.

In concert with the present Science Advisor, I as Chairman of the Committee of Earth Science set up a subcommittee on the Decade in order to formulate the Federal response to the Decade and the Federal responsibility for that. Dr. Bill Hooke of NOAA, a meteorologist by background and a senior member of the science community, is chairman of that subcommittee. And we are well along towards defining what that role should be. He will bring up at the meeting of the Committee on Earth Sciences later—this month—within two weeks, a series of recommendations on what the Federal participation should be and I anticipate that most, if not all, of them will be supported.

In the meantime, we have been supporting, a large and busy committee of the National Academy of Science chaired by Dick Hallgren which is moving forward, Senator. I think it is very important for the U.S. to participate and I am sure we will.

Senator **Gore**. Senator Ford.

Senator **Ford**. Has this vote already been taken at the U.N.?

Dr. **Peck**. No, it is supposed to be taken sometime this week and perhaps later today.

Senator **Ford**. Well fine, but as of this moment, we have abstained.

Dr. **Peck**. Well as of this moment, we were cosponsor of it and it did pass an important committee which is the next step toward——

Senator **Ford**. Well the only thing that concerns me is this is typical of what we do here. You know, we invented the VCR and do not manufacture any of them. We suggested this program on an international basis and then we abstained from it, you know. So the decade of the 1990s is going to be Japanese. In aerospace, there's the FSX, which they are working on. We sit here and just continue to create all these ideas and we never get them in the marketplace.

And so Dr. Peck, the thing that bothers me is that if this was our idea we should have been able to have it on track and in the marketplace; i.e., approved by the U.N., so that we could be in a leadership position with this decade rather than reacting to what everybody else does.

Dr. **Peck**. Some of us would have liked to have had the government be a little bit more proactive in this case.

I will say we have started with AID, the Agency for International Development, and particularly the Office of Foreign Disaster Assistance, a very important pilot project that I think will provide an example and be a leadership role of how this program should be carried out and that is the World Wide Earthquake Risk Management Program.

Senator **Ford**. Well let me look at another thing with you, Dr. Peck. It is clear that if we had some warning time before a major earthquake, the death toll would be greatly reduced. Do you think the scientists will ever be able to predict with some degree of accuracy the date, time and size of an earthquake?

Dr. **Peck**. Yes, I think that we will be able to, but it is going to take quite awhile before we have that capability. I think it is going to come in stages, but it is going to come. Right now we forecast with some success what the most threatening part of the San Andreas fault was and that is where the earthquake occurred. I think through time we are going to, for well studied parts of some faults, predict to a greater degree of assurance and over a shorter period of time.

Also, with dense networks of seismographs, and those are a very important part of studying it, we can identify where the earthquakes are occurring in three dimensions and where the gaps are, where the fault is hung up. And I think that is going to help tell us where future earthquakes will occur.

And then with new technology and new satellites, the NAVSTAR, the global positioning system series of satellites, one was just launched this weekend or it is going to go up—that is the 9th or 10th and they are going to send up 18 or 20. Those allow us to locate positions with respect to the earth as a whole within a quarter inch or less and that is going to allow us to tell how the strain is building up along faults like the New Madrid area, the Reelfoot Lake drift and hence what the likelihood of an earthquake is.

Senator **Ford**. What are the new technologies other than what you just mentioned? Are there some that are about to come on board or some we need or some we could spend some more money on?

Dr. **Peck**. Well we have increasingly sophisticated seismographs and we are starting to install these worldwide and nationwide. These are broad band digitally recording satellite transmission, so that they are not damaged by an earthquake or the signal from them is not limited because of a strong earthquake nearby.

The advent of computers and computer processing of all these data is a tremendous help. And then these new satellite location systems. Those are some of the most important ones.

Senator **Ford**. Mr. Peterson, in your opinion is the Federal Government setting some good examples for the private sector when it comes to building earthquake resistant structures? I know that it is the state and local communities that have the basic authority. But, are we doing anything? Do you just happen to have the answer in your pocket there?

Mr. **Peterson**. I learned this trick when I went before Sam Donaldson in Hugo. We are working with BSSC very closely, they have been extremely supportive to us in providing us very good detailed information as well as USGS and we have been converting that information. Here is a list of our earthquake hazard reduction series, which is strong recommendations to local governments for everything from schools to——

Senator **Ford**. I know, but what are we doing in the construction of new federal buildings.

Mr. **Peterson**. Oh, okay, excuse me.

Senator **Ford**. Anybody can print up a lot of paper, I have seen a lot of paper printed and we have shredded nine out of ten of them. What I want to know is what is the federal government doing? When we build buildings out here and set standards and so forth.

Mr. **Peterson**. Okay. I will not comment on this any more.

Senator **Ford**. Well I have got some of those right here, you should always have those available.

Mr. **Peterson**. Several years of work. Sir, we do have an Executive Order that we have been working on to deal exactly——

Senator **Ford**. How long have you been working on it?

Mr. **Peterson**. We have been working on it for about three and a half years—about two years, we have been completed with our side of it for about a year. There was some strong discussions within OMB between HUD and FEMA, those have been resolved and I believe it is going to come out of OMB where it is now residing, very shortly, sir.

Senator **Ford**. Out here, if you're going west, you have to go through Memphis; and in the Federal Government if you're going anywhere, you have to go through OMB.

I want to go back to the problem of leadership, you have an acting director and one nominee who has been confirmed. I think we have less than 20 nominees that were not confirmed when we recessed, something like that neighborhood. We have been doing our job, so we are just not receiving them.

This is the time of year when the administration's final budget requests are being put together and being hammered out. Now at

FEMA and in a lot of other places—you are not alone—we do not have a director who has been recommended by the President, and approved by the Senate. That makes it harder to hammer out the budget and fight your battle at OMB to get the funds that you need or feel like you want.

So then we hear the cry: We did not get what we wanted! OMB did not take care of us! But it is not your fault. You have not had anybody in the number one slot.

How are we going to help you if we do not have that kind of ability? It is a year now, you know.

Mr. PETERSON. Let me respond to that, if I may, and I would like to take just a little liberty here.

Senator FORD. Take all the liberty you want just as long as you come back to work.

Mr. PETERSON. There was a lot of comment along this line about vacancies during the Hurricane Hugo and Loma Prieta catastrophic events. There were no vacancies except for that director position, and I feel personally fortunate that we had seasoned people in those political positions. I have got almost 50 disasters under my belt and I would have hated to have the responsibility I have now and had that two and a half years ago and walked into that office without that expanse. So there is a seasoned, solid structure of appointees who are there.

And I want to say more specifically to your answer, because I cannot give you the answer as to why an individual has not been nominated, that is totally outside of my purview and I have made some recommendations myself, by the way. But I have had more input with OMB this year than I have had cumulatively in the previous period of time because I have been allowed to go more forcefully as the program manager in dealing with these issues with OMB. And I know they are going to read this testimony and I am sure a couple of the staff level over there at least would agree and concur that they might think I am kind of a pain in the lower side right now because I have taken these issues, especially of the earthquake area, and driven them very forcefully this year personally with OMB. And you know I cannot divulge what I think is going to happen but I think it is going to be very positive.

Senator FORD. You just tell us what they tell you to tell us. We have had that for a long time.

Mr. PETERSON. Sir, I have two obligations that I have been able to exercise this year. The first is I am to support the administration's position, but I also believe firmly and have had a better opportunity this year to do it than I have had in previous years—that is, I also have a responsibility to forcefully recommend to OMB what I believe are the proper policies——

Senator FORD. Mr. Peterson, I do not have any problem with you forcefully recommending your feeling. I just say to you when OMB makes up its mind, you are going to tell us that that is your budget and that is your request and you agree with it. If not, you will leave because you are a good soldier.

The point I am making is that you do not have the kind of leadership at your agency that we need to help you fight the battle. When David picks up the slingshot, you know, that is fine, but there is not a lot of Davids on your side. There are a lot of Goliaths over there and one is called OMB.

So all I want you to have is some effort, some support and I am beginning to be concerned that 25 percent of this administration is over, for all practical purposes and you have seven vacancies out of eight yet to fill. I am very concerned about it and I want to do whatever I can, but the point I am making here is you cannot carry the whole load and should not be asked to carry the whole load.

Now answer one final question. In your earlier statement you said two billion dollars were allocated.

Where did it go and for what?

Mr. PETERSON. This is all in response to the disaster relief legislation that we have presently before us. When we began to run into the catastrophic impacts of St. Croix, immediately thereafter Puerto Rico, two days later South Carolina, then North Carolina, it was obvious that the $100 million that was passed by the Senate and the House to deal with this issue was going to not even begin to cover the cost. So the administration and Congress reacted very responsibly.

We have—are paying for in this instance, more than any other time in history, emergency response resources. We were tasking the military in massive airlifts for Puerto Rico and for the Virgin Islands, over 4.5 million pounds of food alone have been airlifted to St. Croix. That is the kind of thing. Hundreds of generators, every utility truck and lineman and support personnel for St. Croix has been airlifted in, let alone the other hundreds of needs that we have had.

So it is an emergency response——

Senator FORD. Tell me about South Carolina.

Mr. PETERSON. More than just recovery. In South Carolina, we saw one of the most devastating impacts of a hurricane in many years. The debris and the loss of communications capability, the impact of the government substantially in their ability to respond I believe. We came in, tasked the military for clearing the roads and debris, provided special generator systems for sewer pumping areas and as soon as the state and local governments could provide us with a building with power, and that is something we need to look to in the future, sir, is that enough to look at the state and local governments for that—we began placing over 30 disaster application centers up in South Carolina for the purpose of taking over 60,000 applications for assistance for temporary housing, SBA and the Red Cross were also in those facilities to provide assistance.

That is what we have been doing in South Carolina.

Senator FORD. How many applications have you taken that have been paid in South Carolina?

Mr. PETERSON. Can I get to my briefcase and I will tell you?

Senator FORD. You can just tell me later. We are running a little short. We deal with the two Senators from South Carolina and they are not very happy with the results.

That is my last question, Mr. Chairman.

Senator GORE. I would like to say just a word in closing to thank the members of this last panel. You have given excellent statements here and been very helpful in responding to our questions.

And I want to thank all of the witnesses who have been here and all of our guests. Rarely do we have this many people at a field hearing and we are delighted that so many distinguished officials are among the group that has participated today.

I have been asked to remind those attending the CUSEC meeting that the Visions of the Decade program will begin in this same room at 2:00 p.m.

Finally, I would like to especially thank Senator Wendell Ford for coming from Kentucky to attend this hearing today. Everyone here, it goes without saying, realizes that Senator Ford as a senior member of this Committee plays a critical role and has been a great friend to me in helping me in my efforts in this area as well.

I hope that this hearing will help to further the efforts at earthquake preparedness throughout the central United States. The country has understandably thought of earthquakes as a California phenomenon. The experts who helped California by forecasting the Loma Prieta earthquake there and by convincing them over the years to take steps in order to prepare for earthquakes were correct. Luckily, California acted on their advice. It is time now for us to act on the advice from these same experts who are telling us that the local officials here are correct in asking for help, that the people who are running emergency preparedness efforts here are correct in asking for our attention and telling us to make more focused efforts on preparedness. I am hopeful that at the federal level the agencies responsibie for coordinating our national effort will continue to work with these local and state officials and I am confident that they will.

Before we close, Senator Ford, do you have any closing statement?

Senator **Ford**. I will not take but just a minute. It is always a pleasure to work with you, Senator, because you always are effective and efficient. Let me thank the staff from the Committee for their excellent work and Memphis State University for the facilities and the knowledge that we have been able to glean today. Hopefully we can give those who are out there in the trenches some help and I look forward to working with you when we get back in January.

Thank you.

Senator **Gore**. Thank you very much. The hearing is adjourned.

[Whereupon, at 1:11 p.m., the Subcommittee was adjourned.]

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